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The Engineer.

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VOL. CXLVII.—No. 3823] LONDON: FRIDAY EVENING, APRIL 19, 1929 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

HEATING.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Friday, 10th May, 1929, for ACCELERATED LOW-PRESSURE HOT WATER HEATING at the Telephone Exchange, Wandsworth, S.W.

Drawings, specification, a copy of the conditions and form of contract, bills of quantities and forms for Tender may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea. (Cheques payable to the Commissioners, H.M. Office of Works.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 1629

Crown Agents for the COLONIES.

COLONIAL GOVERNMENT APPOINTMENTS.

APPLICATIONS from qualified candidates are INVITED for the following POSTS :—

M/1416.—ASSISTANT ENGINEERS REQUIRED by the GOVERNMENT of NIGERIA for the PUBLIC WORKS DEPARTMENT for two tours of not less than 12 nor more than 18 months' service in the first instance. Subject to satisfactory service, the officers appointed will be eligible at the expiration of three years' service for confirmation in the permanent and pensionable establishment. Salary £480 a year for the first three years, then £510, rising by annual increments to £920. Outfit allowance of £60 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates must have attained the age of 21½ years on the date of appointment, and should preferably have attained the age of 22½, and must not be over 35 years of age. Must have obtained an Engineering Degree at a recognised University or have passed Sections "A" and "B" of the A.M.I.C.E. Examination or have passed the Associateship in Civil Engineering of the City and Guilds Institute, or possess such other Degree or Diploma or Distinction in Engineering as may be considered satisfactory. Candidates whose qualifying diploma have been obtained without a College course should have had three years' practical experience of civil engineering under a qualified civil engineer. It is preferred that all candidates should have had two years' practical experience on good engineering work, subsequent to taking their degree or completing their articles, but under certain conditions this may be waived in the case of candidates in possession of an engineering degree.

M/1376.—ASSISTANT ENGINEER REQUIRED by the RAILWAY DEPARTMENT of the FEDERATED MALAY STATES GOVERNMENT for four years' service, with possible extension. Salary 400 dollars, rising to 475 dollars a month by annual increments of 25 dollars a month, and thereafter in the event of the officer being retained rising to 800 dollars a month plus a temporary non-pensionable allowance of 10 per cent. for bachelors and 20 per cent. for married men. If at the end of four years' service the officer's services have been continuously satisfactory and he does not remain in the service he will be paid a bonus of 2850 dollars. The exchange value of the dollar in sterling is at present fixed by the Government at 2s. 4d., but the purchasing power of the dollar in Malaya is considerably less than that of 2s. 4d. in the United Kingdom. No income tax is at present imposed by the Federated Malay States Government. Free passages provided. Candidates, age 23 to 30, preferably unmarried, must have received a good theoretical training, preferably at a University or a college recognised by the Institution of Civil Engineers and possess a Civil Engineering Degree or obtained such other Diploma or Distinction in Engineering as the Secretary of State may decide in any particular case, or completed their articles with a civil engineer of good standing and have passed the Examination for Associate Membership of the Institution of Civil Engineers. Should have had at least one year's practical experience of Railway Maintenance, including Bridge Design and Erection on a British railway, including, if possible, experience in Drawing-office.

Apply at once by letter, stating age, whether married or single, and full particulars of qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting the reference number against the appointment for which application is made. 1630

Royal Corps of Naval CONSTRUCTORS.

A COMPETITIVE EXAMINATION for a POST as PROBATIONARY ASSISTANT CONSTRUCTOR will be held at the Royal Naval College, Greenwich, during the first fortnight in July next.

Candidates must not be more than 24 years of age on 1st October next, and must then have been engaged in practical shipbuilding work for at least 18 months. Graduates from the Universities are preferred.

The salaries and other conditions of service are given in full in the regulations of the Royal Corps of Naval Constructors. The salaries during the two or three years' Greenwich course, including cost of living bonus reckoned at its present rate of 70, are approximately as follows :—

Probationary Assistant Constructors on joining R.N. College, £190, in addition to mess allowance.

Probationary Assistant Constructors during second half of course, £220, in addition to mess allowance.

Candidates successful at the end of the R.N. College course will be admitted into the Royal Corps of Naval Constructors as permanent Civil Servants, with corresponding superannuation and other privileges, the salaries, including bonus as above, of the lower grades being approximately as follows :—

2nd Class Assistant Constructor (first 3 years), £320-£360.

1st Class Assistant Constructor (after 3 years), £430, rising to £710.

The salaries, &c., for the higher grades are stated in the regulations, which may be obtained from the Secretary of the Admiralty (C.E. Branch), Whitehall, S.W. 1, to whom intending candidates must submit their names and full particulars of their educational and technical training and practical experience not later than Saturday, the 11th May next.

Applications for the regulations should be accompanied by an addressed foolscap envelope.

PRIVATE STUDENTS OF NAVAL ARCHITECTURE.

A QUALIFYING EXAMINATION will be held in conjunction with the above, for the admission to the Royal Naval College, Greenwich, of PRIVATE STUDENTS of NAVAL ARCHITECTURE who desire to receive instruction in the course laid down for Probationary Assistant Constructor. Application for admission as Private Students should reach the SECRETARY OF THE ADMIRALTY (C.E. Branch) not later than the 11th May next.

Private students are required to pay a fee of £50 per session. 1569

The Engineer

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PUBLIC NOTICES

The Government of BURMA REQUIRE the SERVICES of a SANITARY ENGINEER for the Public Works Department, Buildings and Roads Branch, Burma. Candidates should have had a sound general education and a thorough academic training in Sanitary Engineering, particularly water supply and sewerage schemes. They should have obtained a recognised Degree in Engineering or equivalent qualification. In addition they should have had at least five years' practical experience of sanitary engineering design and construction. Age should be between 32 and 40 years. Five years' agreement in the first instance. Pay in accordance with an age scale, e.g., aged 32, Rs. 825 a month plus overseas pay of £25 a month; age 35, Rs. 975 plus overseas pay of £30. (Sterling equivalents at present rates of exchange approx. £1040 : £1237.) Local Allowance Provident Fund. Free first-class passage to Burma and return passage on satisfactory termination of agreement. Oversees pay and return passage is admissible only to a candidate of non-Asiatic domicile. Strict medical examination.

Forms of application and further particulars may be obtained (upon request by postcard) from the SECRETARY TO THE HIGH COMMISSIONER FOR INDIA, General Dept., 42, Grosvenor-gardens, London, S.W. 1. Last date for the receipt of applications 9th May, 1929. 1518

Administrative County of LONDON.

ROBERT BLAIR FELLOWSHIPS IN APPLIED SCIENCE AND TECHNOLOGY.

APPLICATIONS are INVITED for the AWARD of TWO ROBERT BLAIR FELLOWSHIPS in APPLIED SCIENCE and TECHNOLOGY, each of the value of £450, tenable for one year. The Fellowships are for advanced study or research in applied science and technology, and will be tenable in the Dominions, the United States or other foreign countries.

Candidates must be British subjects and at least twenty-one years of age.

Further particulars and application forms (T. 2) 800 may be obtained from the Education Officer (T. 2), the County Hall, S.E. 1 (stamped addressed envelope necessary), to whom the form must be returned by 18th June, 1929.

MONTAGU H. COX,
1574 Clerk of the London County Council.

PUBLIC NOTICES

Portsmouth Municipal College.
Principal : L. B. BENNY, M.A.

ENGINEERING DEPARTMENT.
Head of Department : R. C. PRESCOTT, M.Sc. (Tech.), Victoria.

The Committee invite APPLICATIONS for the POST of LECTURER in CIVIL ENGINEERING and BUILDING TRADES WORK in the Engineering Department of the Municipal College.

Candidates should be Graduates in Civil Engineering, with practical experience, and preferably with the A.M.I.C.E. qualification.

Salary in accordance with the Burnham Scale.

Application forms should be returned not later than May 4th, 1929.

Full particulars and form of application may be obtained from the Secretary at the Municipal College, Portsmouth.

H. E. CURTIS,
Secretary.

Offices for Higher Education,
The Municipal College, Portsmouth.
W/B. 8.4.29./5. 1580

Barry Urban District Council.

NEW WATERWORKS.
CONTRACT A.

The above Council invite TENDERS from experienced contractors for the CONSTRUCTION of the TREFOREST to SOAR SECTION of the PIPE LINE, comprising 871 Yards of 18in. Diameter Cast Iron Pipes, 4395 Yards of 18in. Diameter Steel (Bituminised) Pipes, 628 Yards of Smaller Pipes, and 169 Yards of Tunnel, in the County of Glamorgan.

Forms of Tender, general conditions, specification, and schedule of quantities may be obtained from Edward Sandeman, M. Inst. C.E., Consulting Engineer to the Council, 15, Victoria-street, Westminster, S.W. 1, upon payment of Five Guineas, which amount will be refunded upon receipt of a bona fide Tender.

The drawings can be seen after Monday, the 22nd April, 1929, at the office of the Water Engineer, Broad-street, Barry, Glam., or by appointment at the office of the Consulting Engineer, 15, Victoria-street, Westminster, S.W. 1.

Sealed Tenders, endorsed "Barry U.D.C. Water : Tender for Contract A, Treforest to Soar Section of the Pipe Line," are to be delivered to the undersigned by Twelve Noon on Monday, 5th May, 1929.

The Council do not bind themselves to accept the lowest or any Tender.

T. B. TORDOFF,
Clerk to the Council.

Council Offices,
Barry, Glam.,
15th April, 1929. 1608

PUBLIC NOTICES

The Institution of Petroleum TECHNOLOGISTS.

The Council of this Institution offers a FELLOWSHIP of the value of £300 a year for RESEARCH on PETROLEUM PROBLEMS. The Fellowship will be a full-time appointment, subject to such modifications (if any) as the Council may decide, tenable for one year, and will be renewable at the discretion of the Council, if necessary, for a second year. The Council may at its discretion also make grants towards approved expenses of the Research Work (including College Fees) up to a limit of £50 per annum.

Applications must be received by the 1st June in each year, and must be made on forms which will by provided by the SECRETARY, Institution of Petroleum Technologists, Aldine House, Bedford street, Strand, London, W.C. 2. Applicants, other than Members of the Institution, must be of British Nationality. 1605

Bombay, Baroda and Central INDIA RAILWAY COMPANY.

The Directors are prepared to receive up to Noon on Friday, 3rd May, TENDERS for the SUPPLY of—

1. WHEELS and AXLES for CARRIAGES ; and up to Noon on Friday, 17th May, TENDERS for the SUPPLY of—

2. STEEL MATERIAL (Plates, Channels, Angles, Tees, &c.).

Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of 10s. each (which will not be returned).

The Directors do not bind themselves to accept the lowest or any Tender.

S. G. S. YOUNG,
Secretary.

Offices, The White Mansion,
91, Petty France, Westminster, S.W. 1.
15th April, 1929. 1598

Borough of Llanelly.

GWENDRAETH WATER SCHEME.
CONTRACT No. 1—CAST IRON PIPES AND OTHER CASTINGS.

The Llanelly Corporation invite TENDERS for the SUPPLY and DELIVERY of about 4500 tons of CAST IRON PIPES (mostly 20in. diameter) and OTHER CASTINGS.

Specification, conditions of contract, schedule and form of Tender may be obtained by competent manufacturers upon application to George Watkeys, Esq., Borough Engineer, Town Hall, Llanelly.

Sealed Tenders, endorsed "Tender for Cast Iron Pipes," must be delivered to the undersigned not later than Twelve Noon on Saturday, the 4th May, 1929.

The Corporation do not bind themselves to accept the lowest or any Tender.

HENRY W. SPOWART,
Town Clerk.

Town Hall,
Llanelly.
12th April, 1929. 1575

City of Nottingham.

TRENT NAVIGATION DEPARTMENT.

The Nottingham Corporation invite OFFERS for a STEEL BUCKET and LADDER DREDGER, now at work on the River Trent.

The vessel was built for the Corporation in 1923 and is in good order.

Length between perpendiculars, 76ft. 2in.
Breadth overall, 14ft. 6in.
Draught, 3ft. 6in.
Dredging depth, 18ft.
Engines, 60 H.P. Vertical Compound with Jet Condenser.
Boiler, Marine Type, 120 lb. working pressure.

Further particulars can be obtained from Mr. P. B. Woodger, Engineer, Trent Navigation Committee, Wilford-street, Nottingham.

Tenders, endorsed "Dredger," to be delivered to me not later than Friday, 10th May, 1929.

W. J. BOARD,
Town Clerk.

Guildhall, Nottingham,
April, 1929. 1627

The Assam-Bengal Railway COMPANY, Limited, is prepared to receive TENDERS for—

TURBO-ALTERNATOR SET, for Pahartali.

Specifications and Tender forms may be obtained at the offices of the Company, Bishopsgate House, 80, Bishopsgate, E.C. 2. A fee of £1 1s. is charged for each specification, which cannot, under any circumstances, be returned.

Drawings may be had at the cost of the tenderer, by application to Messrs. Hodges Bennett and Co., Ltd., 78, Queen Victoria-street, E.C. 4.

Tenders must be delivered at the Company's offices not later than Noon on Wednesday, the 8th May, 1929.

The Directors do not bind themselves to accept the lowest or any Tender.

By Order of the Board,
THOS. C. BRETT,
Secretary.

15th April, 1929. 1599

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For Advertisement Rates see Leader Page.

PUBLIC NOTICES

Barry Urban District Council.

NEW WATERWORKS.
CONTRACT B.

The above Council invite TENDERS from experienced contractors for the CONSTRUCTION of the SOAR to ST. LYTHANS SECTION of the PIPE LINE, comprising 3221 Yards of 18in. Diameter Cast Iron Pipes, 8288 Yards of 18in. Diameter Steel (Bitumenlined) Pipes, 670 Yards of Smaller Pipes, and Special Works, in the County of Glamorgan.

Forms of Tender, general conditions, specification, and schedule of quantities may be obtained from Edward Sandeman, M. Inst. C.E., Consulting Engineer to the Council, 15, Victoria-street, Westminster, S.W. 1, upon payment of Five Guineas, which amount will be refunded upon receipt of a bona fide Tender.

The drawings can be seen after Monday, the 22nd April, 1929, at the office of the Water Engineer, Broad-street, Barry, Glam., or by appointment at the office of the Consulting Engineer, 15, Victoria-street, Westminster, S.W. 1.

Sealed Tenders, endorsed "Barry U.D.C. Water: Tender for Contract B, Soar to St. Lythans Section of the Pipe Line," are to be delivered to the undersigned by Twelve Noon on Monday, 6th May, 1929.

The Council do not bind themselves to accept the lowest or any Tender.

T. B. TORDOFF,
Clerk to the Council.

Council Offices,
Barry, Glam.,
15th April, 1929. 1609

Sandown Urban District

COUNCIL—WATERWORKS.
(CONTRACT NO. 3.)

The above Council invite TENDERS for the SUPPLY of VALVES, HATCH-BOXES, and other IRONWORK required in connection with their new Aqueducts. The valves, &c., vary from 12in. to 30in. diameter. The specification, schedule, and form of Tender may be obtained on application at the offices of Messrs. G. H. Hill and Sons (Manchester), 40, Kennedy-street, Manchester, upon receipt of a cheque for One Guinea, which will be returned to the applicant provided that he shall have sent in a bona fide Tender and shall have not withdrawn the same, and shall have returned the documents and drawings lent to him.

Sealed Tenders, endorsed "Contract No. 3, Valves and Ironwork," and addressed to the "Chairman of the Waterworks Committee," must be delivered at the office of the Clerk of the Urban District Council, Town Hall, Sandown, Isle of Wight, not later than the 14th day of May, 1929.

The Council do not bind themselves to accept the lowest or any Tender.

NORMAN WAINE,
Clerk to the Council.

Town Hall, Sandown, I.W.,
15th April, 1929. 1586

South Indian Railway Company, Limited.

The Directors are prepared to receive TENDERS for the SUPPLY of—

FIVE Four-Wheel PETROL TANK WAGONS (Broad Gauge), and
25 BOGIE PETROL TANK WAGONS (Metre Gauge).

Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked:—"Tender for Petrol Tank Wagons," with the name of the firm tendering, must be left with the undersigned not later than Twelve Noon on Friday, 10th May, 1929.

The Directors do not bind themselves to accept the lowest or any Tender.

A charge, which will not be returned, will be made of £1 for each copy of the specification.

Copies of the drawings may be obtained at the offices of the Company's Consulting Engineers, Messrs. Robert White and Partners, 3, Victoria-street, Westminster, S.W. 1.

A. MUIRHEAD,
Managing Director.

91, Petty France,
Westminster, S.W. 1.
17th April, 1929. 1651

Stourbridge Main Drainage Board.

TO STEAM BOILER MANUFACTURERS.

The Stourbridge Main Drainage Board invite TENDERS for the SUPPLY and ERECTION at their Sewage Pumping Station of a 7ft. by 24ft. LANCASHIRE STEAM BOILER to carry a pressure of 180 lb. with SUPERHEATER, and WATER and STEAM CONNECTIONS.

Form of Tender, general conditions and specification may be obtained from Mr. G. Plant Deeley, the Engineer to the Board, 13, Church-street, Stourbridge, on and after Monday, April 22nd, on payment to the undersigned of £3 3s., which sum will be returned on receipt of a bona fide Tender on the form provided.

Sealed Tenders, addressed to me and endorsed "Tender for Steam Boiler," must be delivered at my office on or before Noon on Thursday, the 23rd day of May next.

The Board do not bind themselves to accept the lowest or any Tender.

GEOFFREY INCE,
Clerk to the Board.

High-street, Stourbridge,
April 16th, 1929. 1606

Stourbridge Main Drainage Board.

PUMPING MACHINERY.

The Board invite TENDERS for the SUPPLY, DELIVERY and SETTING TO WORK at their Sewage Pumping Station, Enville-street, Stourbridge, of a TRIPLE-EXPANSION VERTICAL DROP VALVE ENGINE directly connected with a SET of VERTICAL THREE-THROW SEWAGE TYPE RAM PUMPS, capable of delivering 1400 gallons per minute of screened sewage, against a normal head of 198ft., including friction in rising main, together with all ACCESSORIES to make the plant complete in every detail.

Copies of the plans, specification, and form of Tender may be obtained from the Engineer, Mr. G. Plant Deeley, M. Inst. M. and Cy. E., 13, Church-street, Stourbridge, on and after Monday, April 22nd, 1929, on payment to the undersigned of £3 3s., which sum will be returned on the receipt of a bona fide Tender on the form provided.

Facilities for inspecting the site and other information can be obtained on application to the Engineer.

Sealed Tenders, addressed to me and endorsed "Tender for Pumping Plant," must be delivered at my office on or before Noon on Thursday, the 23rd day of May next.

Only Tenders from experienced engine and pump manufacturers will be considered.

The Board do not bind themselves to accept the lowest or any Tender.

GEOFFREY INCE,
Clerk to the Board.

High-street, Stourbridge, Worc.,
April 16th, 1929. 1607

Tyne Improvement Commission.

TWIN-SCREW STEAM FERRY BOAT.

The Tyne Improvement Commissioners invite TENDERS for the CONSTRUCTION and DELIVERY in the Tyne of a TWIN-SCREW STEAM VEHICULAR and PASSENGER FERRY BOAT.

Copies of the form of Tender, conditions of contract, specification and outline drawings may be obtained on application to the undersigned on payment of a deposit of £2 2s., which will be returned on receipt of a bona fide Tender.

Tenders, in sealed envelopes, addressed "The Chairman, Tyne Improvement Commission," and endorsed "Tender for Ferry Boat," must be delivered at the undermentioned offices not later than Noon on Thursday, the 16th day of May, 1929.

The Commissioners do not bind themselves to accept the lowest or any Tender.

By Order,
ALBERT BLACKLOCK,
Secretary.

Tyne Improvement Commission,
Bewick-street,
Newcastle-upon-Tyne,
15th April, 1929. 1581

PUBLIC NOTICES

TO ENGINEERING CONTRACTORS.

The Corporation of Liverpool

invite TENDERS for the ENGINEERING WORK required at proposed Reconstructed Washhouse, Steble-street.

Plans, specification, and form of Tender may be obtained on application to the Baths Manager, Baths Department, 75, Dale-street, on payment of One Guinea, which will be returned on receipt of a bona fide Tender.

Tenders must be enclosed and sealed up in the official envelope provided, addressed to the Town Clerk, Municipal Buildings, Liverpool, and endorsed "Tender for Engineering," and delivered by letter post not later than 10 a.m. on Wednesday, the 8th May, 1929.

The Corporation do not bind themselves to accept the lowest or any Tender.

WALTER MOON,
Town Clerk.

Liverpool, 19th April, 1929. 1595

STRUCTURAL STEEL FOR SALE.

The Commissioners of Public Works, Dublin,

have FOR SALE at Kilteagh disused Airship Station on Great Southern Railway line, 20 miles from Cork, SEVERAL HUNDRED TONS of STEEL, viz., Lattice Girders, Columns, Stanchions, Joists, Plates, &c.; and a QUANTITY of other MATERIALS, viz., Railway Rails (about 20,000ft. lineal) Corrugated Iron, Gas and Water Pipes, Nuts, Bolts, &c.

An illustrated schedule of the materials can be obtained on application at this office on deposit of £1, which will be refunded on return of the schedule.

Copies of the schedule may be inspected free at this office or at the District Office of Works, Government Buildings, Patrick-street, Cork, where order to view the property may be obtained.

Sealed Tenders for the purchase of the materials as a whole or in lots will be received up to Twelve Noon on 10th May, 1929.

The Commissioners will not be bound to accept the highest or any Tender.

T. CASSEDY, Secretary.

Office of Public Works,
51, St. Stephen's Green, Dublin,
30th March, 1929. 1485

25/A. 2413. W. H. Co.

SALE OF OLD METAL.

The Corporation of Trinity House

have FOR SALE about 29 TONS (more or less) of OLD METAL (Wrought Iron, Burnt Cast Iron, Mixed Cast Iron and Mixed Mild Steel), now lying at their Workshops at Trinity Wharf, Blackwall, London.

Particulars and conditions of sale can be obtained on application to the SECRETARY, Trinity House, Tower-hill, London, E.C. 3, mentioning this paper. 1585

IRISH FREE STATE.

Hydro-Electric Development on River Shannon.

VACANCY FOR CHIEF OPERATION ENGINEER.

The Irish Free State Electricity Supply Board INVITE APPLICATIONS for the POSITION of CHIEF OPERATION ENGINEER for the River Shannon Hydro-Electric Development.

Applicants should possess a recognised University Engineering Diploma and must have had practical experience of the operation and maintenance of a large scale hydro-electric generating station, high tension transmission lines and transformer stations.

Appointment in the first instance for three years. Salary £1200 per annum.

Applications, stating age, qualifications and experience, should be addressed to:—The SECRETARY, Electricity Supply Board, 60, Upper Mount-street, Dublin. 1578

PUBLIC NOTICES

City of Norwich Mental Hospital.

WANTED, FOREMAN WORKING MECHANICAL ENGINEER for a permanent post leading to pension, to Take Charge of Boilers and all Steam, Water and Electric Plant; age not over 42; ex-Naval Engine-room Artificer preferred; gross wages £4 per week, subject to 5s. 9d. rental for cottage and garden with water supply on the premises, and to contributions under the National Health, National Unemployment, and Asylum Officers' Superannuation Acts.—Applications, stating age, present employment and previous experience by letter only, to the MEDICAL SUPERINTENDENT, Hellesdon Hospital, Norwich. 1622

City of Nottingham.

TRAMWAYS DEPARTMENT.
APPOINTMENT OF ASSISTANT ROLLING STOCK SUPERINTENDENT.

The Tramways Committee invite APPLICATIONS for the POSITION of ASSISTANT ROLLING STOCK SUPERINTENDENT. The salary will be in accordance with Grade D of the Corporation's Grading Scheme; gross salary £375, net £320 17s. 2d.

Candidates for the position must have had previous experience in connection with Tramways and Motor Buses.

Applications, stating age, qualifications, and giving full details of education, and previous experience, accompanied by copies of not more than three recent testimonials, and endorsed "Assistant Rolling Stock Superintendent," must reach the undersigned not later than the first post on the 27th day of April, 1929.

W. J. BOARD,
Town Clerk.

Guildhall, Nottingham,
11th April, 1929. 1577

Municipal Corporation of Rangoon.

APPOINTMENT OF SECOND OFFICER, FIRE BRIGADE.

The Municipal Corporation of Rangoon invites APPLICATIONS for the POST of SECOND OFFICER, FIRE BRIGADE. Applicants must be qualified and trained mechanical engineers with fire brigade experience, and should not be under 25 or over 30 years of age. They should also state nationality, qualifications and what previous experience they have had in the working of a Fire Brigade. Preference will be given to candidates who are members of the Institute of Fire Engineers (class to be stated). An intimate knowledge of Internal Combustion Engines and Pumping Machinery is essential. The salary offered is Rs. 400 for the first year, rising by annual increments of Rs. 20 to Rs. 500 per month, with free quarters, lights, fans, and water, and the use of a service car while on duty. The appointment will be permanent subject to a probationary period of one year. A free first-class passage from the nearest port to Rangoon will be provided and leave and leave allowances will be in accordance with the Fundamental Rules applicable to officers in superior service under the Government of India. The officer appointed will be required to subscribe to the Municipal Provident Fund. Subscriptions are payable at the rate of 8 1-3 per cent. of salary and an equal amount is contributed by the Municipal Corporation. The successful candidate will be required to pass a medical examination by a medical officer nominated by the Corporation or its duly authorised agents and to abide by all the rules and regulations in force for officers of the Corporation of Rangoon.

Applications should be forwarded to the undersigned and should reach them not later than the 15th May, 1929. All applications will be sent to Rangoon for final selection. Application forms are not supplied.

OGILVY GILLANDERS & COMPANY,
Ref. R.2988, Sun-court,
1534. 67, Cornhill, London, E.C.

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

WANTED by a Water Company in the South of England, a thoroughly competent ENGINEER MANAGER and SECRETARY; one having had experience of Water Pumped from the Chalk preferred.—Address, stating age and experience, with copies of testimonials, 1508, The Engineer Office. 1508 A

WANTED, Young ENGINEER, Preferably either just from university or with few years' Sales Engineering experience. Fluent French essential and good knowledge either German or Spanish, but preferably both. Permanent employment with ample scope for advancement for right man. Full particulars as to age, education, training, and experience by letter.—Address, 1434, The Engineer Office. 1434 A

ASSISTANT SUPERINTENDENT REQUIRED for Works Rolling and Drawing Special Sections in Steel and Non-ferrous Alloys. Must have first-class experience and be able to design tools, control annealing, &c.—Address, stating experience and salary expected, 1583, The Engineer Office. 1583 A

The GENERAL AGENCY is to be ceded of a modern already successfully introduced HIGH-PRESSURE LUBRICATOR, to a well connected firm or manufacturers of fittings, etc.
Address, 1626, The Engineer Office 1626

THE
ENGINEER DIRECTORY, 1929.

The New Edition is now available and may be had on application free of charge

This Directory is published in the interests of our advertisers, and contains a mass of information very useful to those engaged on the Commercial Side of the Industry.

Application to The Manager,
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For continuation of Small Advertisements see page 4.

A Seven-Day Journal

Rebuilding the Attock Bridge.

THE reconstruction of the Attock Bridge on the Indian North-Western Railway between Lahore and Peshawar has now been so far completed that it only remains to remove the substructure on which the new bridge has been built and to dismantle the fifty-year-old existing structure, which is now enclosed by the new spans. The two new 300ft. spans pass over the river Indus at a height of 140ft. above the water level and below the rail track is a military road. Reconstruction of the bridge has been rendered necessary in order that recently acquired locomotives with a 22-ton axle load may be utilised. Actually the new bridge is designed to bear the weight of 28-ton axle load locomotives, if such engines are ever required. The two central spans were built out on a special substructure which was anchored to the new concrete piers designed by Messrs. Rendel, Palmer and Tritton, of Westminster, who are the consulting engineers to the railway company. The scheme for the rebuilding of the bridge was prepared and has been supervised throughout by Mr. W. T. Everall, the bridge engineer to the Indian North-Western Railway. The whole of the work has been carried out without interfering with either the rail or road traffic.

Railways and Air Transport.

A JOINT committee of the House of Lords and the House of Commons, under the chairmanship of the Earl of Kintore, on Tuesday, began the consideration of a group of Bills entitled the Railway Air Transport Bills, under which the railways seek power to provide air transport services and to apply their funds for that purpose. For the railway companies Mr. Macmillan, K.C., contended that if there were new forms of transport the companies should be allowed to participate in them. The County Council of Fife was alone in opposing the granting of the powers sought in the Bills. By agreement with Imperial Airways, Mr. Macmillan continued, clauses had been inserted in the Bills that would have the effect of preventing the railway companies from running flying services to India, but would permit them to fly East almost as far as Warsaw. By agreement with the aircraft constructors the companies undertook, if the powers sought were granted, not to manufacture for themselves the machines which they would require. Sir Herbert Walker, giving evidence in support of the Bills, stated that it was proposed to establish air services connecting London and the provincial towns and also linking up ports on the South Coast, such as Dover, Portsmouth, Southampton, and Plymouth. There would also be services to Ireland and the Continent.

The New American Warships.

SOME interesting details of the new American ships authorised under the recently passed Naval Construction Bill have been transmitted from Washington. The largest of these vessels is an aircraft carrier, to be laid down in the present year. In contrast with the "Lexington" and "Saratoga," of 33,000 tons, she will displace only 13,800 tons. Speed is to be sacrificed to aeroplane capacity, and the armament limited to light anti-aircraft guns. Provision is to be made for the stowage of seventy-two aeroplanes, with the possibility of increasing the number to a hundred by rearrangement of internal spaces. The decision to accept a low speed is surprising, and runs contrary to the lessons of experience with ships of this class. The fifteen cruisers are to be built to a more or less standard design of 10,000 tons, nine 8in. guns triple mounted, and speeds of 32 to 33 knots. Their equipment will include two catapults and four to six seaplanes, two of which will be mounted on the catapults and the others on deck in position for immediate use. Geared turbine machinery is to be installed in all the cruisers. Protective armour plating will be limited to the machinery spaces, magazines, and gun positions. Each ship, in addition to her main armament, will carry four 5in. anti-aircraft guns and six torpedo tubes. It is now admitted that the first pair of 10,000-ton cruisers, "Salt Lake City" and "Pensacola," which mount ten 8in. guns each, are over-gunned. The inordinate weight on the deck is expected to make them very lively at sea, thus preventing the effective use of their imposing main armament.

Boilermakers and the Shipyard Agreement.

AFTER a second vote, the members of the Boilermakers' Society have once again rejected the Shipyard Procedure Agreement, which was specially drafted to meet the requirements of pieceworkers and was recommended by the Executive Council of the Society. This agreement was accepted by the Shipbuilding Employers' Federation and was supplementary to that concluded between the Federation and the other shipyard and engineering trade unions. The Council, in recommending the agreement to its members, pointed out that the new clauses would become a vital part of procedure. In case of disagreement it was provided that an arbitrator mutually agreed upon should be asked to decide. Moreover, the existing price must be paid pending further negotiations, so that a disputed job could be proceeded with while any further procedure necessary to fixing a definite price was being established. It was further pointed out by the Council that the acceptance of the new agreement would regularise methods of negotiation and expedite local settlements, assuring a reasonable wage pending the settlement of any question of difference and thereby obviating loss of time on all yard matters and questions of the interpretation of price lists. In spite of the Council's recommendations, in the February vote 2209 members voted for the agreement and 2272 against, leaving a negative majority of 63. The Council did not regard this as a satisfactory vote and called for a second vote, which was taken at the March meetings, when 2560 members voted for the agreement and 2906 against it, giving a majority against of 346. As reported in our last week's Journal note, the shipyard and craft unions are now putting forward another claim for a general wages advance, but in the case of the boilermakers it is pointed out that over 90 per cent. of the members are pieceworkers and the conditions and method of application of wages rates have an important bearing on the real value of any proposed increase.

New Steamers for Canada.

IN a period of a little over a week Swan, Hunter and Wigham Richardson, Ltd., have completed for Canadian owners no less than eight sister ships which are to be employed in service on the Great Lakes and the St. Lawrence River. Two other ships of the same type were recently launched and are now being fitted out. Each of the ships referred to has an overall length of 260ft., with a beam of 43ft. 4in. and a moulded depth of 20ft., the deadweight carrying capacity being 2000 tons. The steamers have been built to the special Canadian lake and river requirements of the British Corporation Register, and under the supervision of the representative of the owners, Mr. John Dunlop, of London. There are two large cargo holds served by six hatches and special warping winch gear and fairleads are so arranged that the ship can easily be handled in canal locks and when alongside grain elevators. The winches and the anchor windlass were supplied by Harfield and Co., Ltd., of Blaydon-on-Tyne. The main propelling machinery comprises a single set of three-crank triple-expansion steam engines, and steam is raised in two single-ended 180 lb. boilers working on the Howden forced draught principle. Two of the steamers were engined by MacColl and Pollock, Ltd., of Sunderland, and the machinery for the other ships was made by the builders, who also supplied the electric lighting plants. In addition to the ships we have mentioned and others now on order from Canadian owners, it is expected that an order will shortly be placed for three steamers for the Canadian National Steamship services between Vancouver and Seagway, for which both British and Canadian shipyards were recently asked to tender prices.

An Electric Train Service to Altrincham.

WORK is being begun this month on the erection of the overhead electrical equipment in connection with the electrification of the Manchester South Junction and Altrincham line of the London and North-Eastern and the London, Midland and Scottish railways. The line is to be electrified on the 1500-volt direct-current system, in accordance with the report of the Railway Electrification Committee of 1927. The rolling stock will consist of six-car trains of the compartment type, which will be divided into three-car units. Each six-car train will have a seating capacity for 536 passengers. When the scheme is put into operation there will be a 50 per cent. increase in the train mileage over the augmented steam service, or 80 per cent. over the steam service in 1927. Two new stations at Dane-road and at Navigation crossing (North Altrincham) are to be constructed, and it is intended to open the Old Trafford Cricket Ground Station permanently. An electric train repair and inspection depôt will be established at Altrincham. The Manchester South Junction and Altrincham Railway from London-road to Ordsall-lane *viâ* Oxford-road was begun in 1845. Later the portion of the line from Oxford-road to Altrincham was completed and the first steam train was run over the whole distance of 8¾ miles in 1849. The jubilee of the Manchester South Junction and Altrincham Railway fell in 1899, when a special publication was issued commemorating the event. The line has therefore been working under steam conditions for a period of eighty years. Early in 1928 a recommendation was made by the Joint Committee to the boards of the London, Midland and Scottish, and London and North-Eastern railways that the electrification of the line should be proceeded with.

The Late Mr. A. E. Angold.

THE sudden death of Mr. Arthur Ernest Angold on April 10th, in Birmingham, removes a gifted and brilliant engineer from the electrical profession. Mr. Angold was born in December, 1872, and began his professional career at a time when the electrical manufacturing industry was just beginning to find its feet. His early engineering training was received in London, and during part of it he was employed by a firm trading in lightning conductors and electrical bells. In 1890 he designed and made at home his first arc lamp. The design met with the approval of Mr. Torr Todman, of Bermondsey, with the result that Angold joined Todman and started an arc-lamp department. One of the earliest contracts received by the firm for Todman-Angold arc lamps was for an installation for a tailor's shop in Borough High-street. The order comprised about seventy lamps, each taking 10 ampères on a 50-volt 83-cycle circuit, that of the old Deptford Station. In 1892 the General Electric Company, then in its early days, took over Todman's arc lamp department, and in that way Angold entered the service of the company with which he was engaged until the day of his death. The original Angold open type arc lamp as made in the G.E.C.'s Thames-street works soon became famous, and in due time was followed by the Angold enclosed and flame-type arcs. At a later date Angold introduced the magazine arc and special studio and photographic arcs. During the war he applied his wide experience to the improvement of searchlight arcs for the Naval and Air Services. In addition to his work on arc lamps, Angold made many notable contributions to the development of electrical machinery, switchgear and instruments, and in particular to the development of automatic sub-stations and high-speed circuit breakers.

The Holland-America Liner "Statendam."

ON Thursday evening of last week, April 11th, the newly completed Holland-America liner "Statendam" called at Cowes Roads to take on board Southampton passengers and resumed her maiden voyage to New York. Her arrival is to be specially celebrated in commemoration of the three hundredth anniversary of the arrival of the first Dutch ship in New York. The new liner is of particular interest to marine engineers, as her propelling machinery represents a still further advance in the application of high-pressure steam turbine machinery to ship propulsion. The "Statendam" has an overall length of 697ft., with a beam of over 81ft. and a depth of 53ft. 6in. Her gross tonnage is 30,000, and she is designed to carry between 1600 and 1700 passengers, with a crew of 600. The passenger accommodation is of a very high order, and was principally designed by H. P. Mutters and Co., of Rotterdam. The propelling machinery comprises twin-screw, three-stage expansion Parsons single-reduction geared turbines, with a designed output of 20,000 S.H.P. The three-bladed propellers run at a normal speed of 125 r.p.m., and on trial a speed of 19 knots was obtained. The six boilers, of which five are in normal operation, are of the Babcock and Wilcox oil-fired water-tube type, and are designed for a working pressure of 425 lb. with 600 deg. Fah. total superheated steam temperature. A drawing of one of the boilers was reproduced in last week's issue of THE ENGINEER. Most of the deck and engine-room auxiliary machinery is electrically-operated, and current for lighting and power purposes is supplied by four 400 kW oil-electric generator sets, any three of which are designed to carry the full working load. The hull and engines of the "Statendam" were built by Harland and Wolff, Ltd., at Belfast, and the ship was fitted out and the machinery installed at the works of Wilton's Engineering and Slipway Company at Rotterdam, the work being completed two weeks earlier than was provided for in the contract.

Safety of Life at Sea.

ON Tuesday, April 9th, the first meeting of the International Conference on the Safety of Life at Sea took place at the Foreign Office. Delegates from practically all the maritime countries were present. In opening the Conference Sir Philip Cunliffe-Lister, said that the purpose of the Conference was to review the Convention of 1914. As the conveners of the Conference Great Britain had submitted to all the Governments concerned, tentative but detailed proposals of revision, and in reply several Governments had furnished their observations, which had again been circulated. Vice-Admiral Sir Herbert Richmond, the chairman of the British delegation, was elected the President of the Conference, and in his introductory speech he referred to the four kinds of measures to be taken. They were, he said, measures to avert the occurrence of accidents; the construction of ships so as to mitigate the results of accidents should they occur; means for obtaining assistance, and means for sustaining life until that assistance arrived or the security of land was reached. The object of shipping was, he pointed out, to provide intercommunication between the peoples of the world, and measures which might restrict such intercommunication could only be disadvantageous to all concerned. It would confer the greatest benefit on the world in general if the Conference could remove as many hindrances as possible which stood in the way of freedom to trade. The Conference proceeded to appoint the various committees, and on the evening of Tuesday the delegates were welcomed at a Government dinner held at the Mayfair Hotel, at which Sir Austen Chamberlain presided. After the dinner a reception took place at Lancaster House.

Development of the Ljungström Locomotive.

No. III. (*conclusion*).*

The Third Ljungström Locomotive.

The next Ljungström locomotive to be completed was that constructed by Beyer, Peacock and Co., Ltd., of Manchester, under licence from the Aktiebolaget Ljungströms Angturbin. This machine, which we illustrate in Fig. 12, was ready for trial in September, 1926. It made its first trip—a 19-mile journey, running light—on September 23rd, on the L.M.S. Railway, and from that date to May 5th, 1927, had covered a total distance of 5402 miles. The principal particulars of this locomotive are given in Table VII.

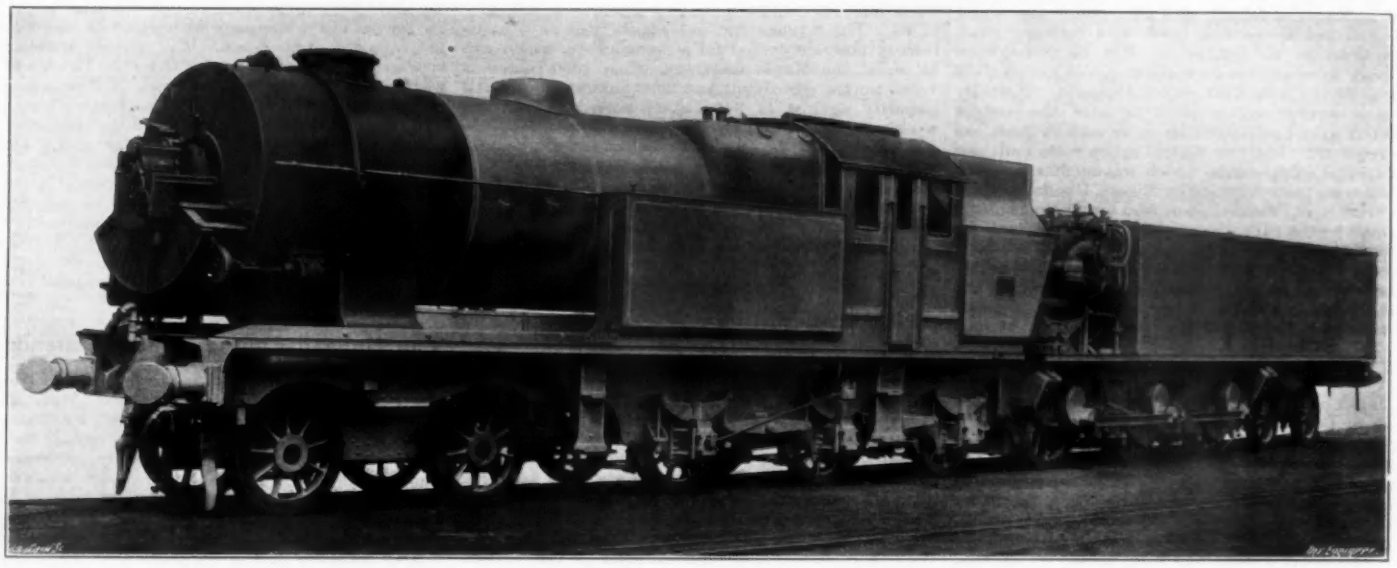


Fig. 12—Beyer-Peacock-Ljungström Locomotive

The design of the Beyer Peacöck Ljungström locomotive embodies the same departures from the design of the original Ljungström locomotive as were noticed in connection with the engine for the Argentine

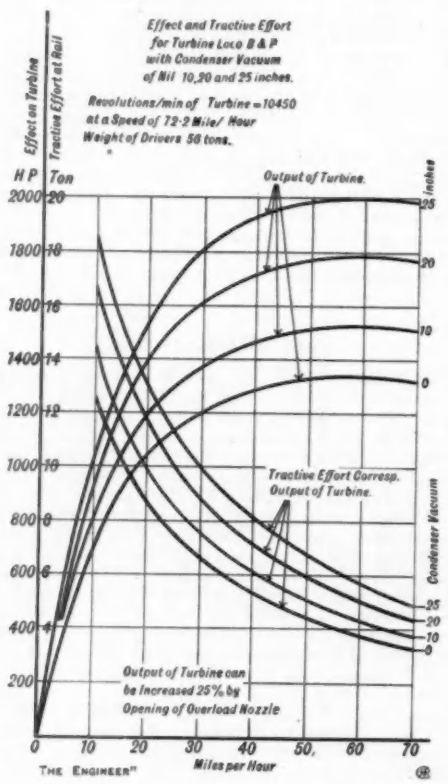

Effect and Tractive Effort for Turbine Loco B & P with Condenser Vacuum of Nil 10,20 and 25 inches.
Revolutions/min of Turbine = 10450 at a Speed of 72·2 Mile/ Hour
Weight of Drivers 58 tons.
Effect on Turbine
Tractive Effort at Rail
H P
Ton
Inches
Output of Turbine.
Tractive Effort Corresp. Output of Turbine.
Condenser Vacuum
Output of Turbine can be Increased 25% by Opening of Overload Nozzle
Miles per Hour
THE ENGINEER

Fig. 13—Diagram of Performance of Beyer-Peacock-Ljungström Locomotive

described last week. The rotary air heater instead of the old tubular type; the triple-reduction gearing, with a flexible connection to one of the driving axles, in place of the double-reduction gearing and jack shaft; the mechanically operated reversing gear instead of the oil relay system of reversal; and the arrangement of the cooling elements vertically along the sides of the condenser car, instead of on the top are all features of the Beyer-Peacock machine. Being, like its Swedish prototype, a coal-burning machine, the best position for the coal bunker had to be considered with regard both to ease of firing and access to the turbine machinery behind the footplate. In the first Ljungström locomotive the problem was solved by using a saddle back bunker over the rear end of the boiler. This, while satisfactory in many respects, had the disadvantage of limiting the range of vision of the driver and fireman, in spite of the fact that the bunker was so shaped as to cause as little interference with the outlook as possible. Hence, in the Beyer-Peacock design the saddle bunker was abandoned in favour of a bunker behind the footplate, as will be seen in the illustrations.

The capacity of the locomotive under different conditions of speed and vacuum is shown in the diagram—Fig. 13. With a vacuum of 25in., which is the average realised under ordinary conditions of service, the turbine develops 2000 B.H.P. at a speed of 60 miles per hour, the power not being appreciably less over the range from 50 to 70 m.p.h. This power can be increased by 25 per cent. by opening the overload nozzle. Even should the vacuum be lost entirely, the turbine will still be capable of maintaining 1325 B.H.P. over a good range of speed. The tractive effort which can be developed at starting and at low speeds is limited by the slipping of the wheels, but owing to the absolute steadiness of the turning effort, slipping will not occur nearly as readily, for a given adhesive weight, as in the case of an ordinary locomotive. The turbine principle permits of a starting effort about 25 per cent. greater, for a given weight on the drivers, than can be obtained with a piston locomotive, and it will be seen that a draw-bar pull of no less than 19 tons can be maintained at a speed of 10 miles per hour with the Beyer-Peacock-Ljungström locomotive, with the usual working vacuum in the condenser.

Table VII.—*Beyer-Peacock-Ljungström Locomotive, Chief Particulars.*

Length over buffers	73ft. 11in.
Weight in running order	143 tons 14 cwt.
Weight of condenser car	73 tons 18 cwt.
Weight of boiler car	69 tons 16 cwt.
Weight on driving axles (3)	54 tons 12 cwt.
Diameter of driving wheels	63in.
Total wheel base	63ft.
Tractive effort, maximum, at draw-bar	18 tons
Maximum normal speed	75 miles per hour
Coal bunker capacity	6 tons
Boiler pressure	300 lb. per sq. in.
Grate area	30 sq. ft.
Boiler heating surface (total)	1620 sq. ft.
Fire-box heating surface	140 sq. ft.
Superheater surface	640 sq. ft.
Condenser surface	13,200 sq. ft.
Final temperature of flue gas	150 deg. Cent.
Power of turbine	2000 B.H.P.
Speed of turbine at 75 miles per hour	10,500 revs.
Ratio of gearing to drivers (triple reduction)	26·25 : 1

The Fourth Ljungström Locomotive.

We have already mentioned that about the same time as Messrs. Nydqvist and Holm received the order for the oil-burning locomotive for the Argentine State Railways, they also entered into a contract to supply another locomotive on the Ljungström principle to the Swedish State Railways. Work on the latter machine was delayed by the necessity of hastening the construction of the Argentine locomotive, so that it was not before January, 1927, that it could be handed over to the Swedish Railway Administration. The Swedish locomotive is illustrated in Fig. 14. It is of the same horse-power as the Beyer-Peacock locomotive, namely 2000 B.H.P. normal, with a maximum of 2400 B.H.P. It has also the same 10–6–4 wheel arrangement, and is built to standard gauge of track. The Swedish conditions, however, required a maximum speed of only 56 miles per hour. The axle load was also kept down to 16·5 tons and a tractive effort of 14·8 tons was sufficient. The wheel base also is slightly shorter than that of the English machine, being 18·5 m., as against 19·5 m. The leading particulars of the locomotive are given in Table VIII.

Table VIII.—*Data of the Swedish Turbine Locomotive.*

Length over buffers	75·46ft.
Weight in running order	154·5 tons
Weight of condenser car	77·75 tons
Weight on driving axles	48·72 tons
Diameter of driving wheels	60·23in.
Tractive effort, maximum	14·56 tons
Maximum normal speed	55·9 m.p.h.
Coal bunker capacity	7·38 tons
Boiler pressure	284 lb./sq. in.
Grate area	31·2 sq. ft.
Boiler heating surface	1453 sq. ft.
Superheater surface	807 sq. ft.
Condenser surface	14,500 sq. ft.
Final temperature of flue gases	338 deg. Fah.
Power of turbine	2000 B.H.P.
Speed of turbine at 90 kiloms per hour	10,000 r.p.m.
Ratio of gearing to drivers	32·25 : 1

As to general design, this locomotive embodies the same departures from the practice followed in the experimental machine as had been adopted in the case of the Argentine and the English locomotives. The condenser with side cooling panels, the fans driven by a separate turbine, the triple-reduction gear and spring drive to the leading driving wheel, the mechanical reversing gear and the rotary Ljungström air heater, are all features of the design. Since March 22nd, 1927, the Swedish locomotive has been in regular service. On that day it took the 10 a.m. express train from Stockholm to Krylbo, returning in the afternoon with the 4.20 express from Krylbo. The length of the double trip was fractionally over

Fig. 14—Ljungström Locomotive for Swedish State Railways, 1927

* No. II. appeared April 12th.

200 miles. This work was performed steadily day after day until April 18th, the outward run being made in 2 h. 41 min. and the return in 2 h. 38 min. with trains ranging from 270 to 330 tons behind the engine. It was then decided to give the engine a longer trip, and it was put on the Stockholm-Bol'näss service. It left Stockholm at 7.06 p.m., reaching Bollnäss at 1.20 a.m. the next morning, leaving again at 3.40 a.m. and arriving at Stockholm at 9.43 a.m. The daily run amounted to 393·74 miles, the train weight, exclusive of engine, being generally from 350 to 380 tons. At the present time the engine is working regularly on the Stockholm-Krylbo route, and so commonplace has it become that it receives hardly a glance from the passengers on the stations, and certainly attracts no more attention than any ordinary large locomotive would do.

The fuel consumption of the locomotive is represented graphically in Fig. 15. Line No. I. on the chart represents the mean of fifty-three runs made between Stockholm and Krylbo from February 22nd to May 4th, 1928. For every trip the total fuel consumption was plotted against the total weight of the train, including the engine, and the line No. I. drawn as fairly as possible through the points so obtained. The length of the run in every case was 167 kiloms., including the distance between the Hagalund sheds and Stockholm Station. Half the runs were in one direction and half in the other. The coal consumed, naturally, varied with the weather, and the amount of train heating necessary, and some train crews seemed able to work the locomotive more economically than others. In order to eliminate the merits or otherwise of the drivers, points have been plotted on the chart representing eleven performances of a single train crew, with trains ranging from 386 to 632 tons, including the engine. The results got better and better as experience with the locomotive was gained, and they also became more consistent with each other. The improvement is shown by line II. on the diagram, which is the mean of twenty-two results obtained between April 6th and May 4th, 1928, and therefore included in those which formed the basis of line I. The remaining line, No. III., was drawn to pass through the best five points included in the group of line II. As the whole of the five points fell exactly on line III., this line may be taken as representing the best performances of the locomotive up to the end of April last. The equation to the line is

$$C = 711 + 1{\cdot}84\ W,$$

where C represents the total coal consumption in kilogrammes for a train weighing W tons, including the engine, working over a distance of 167 kiloms.

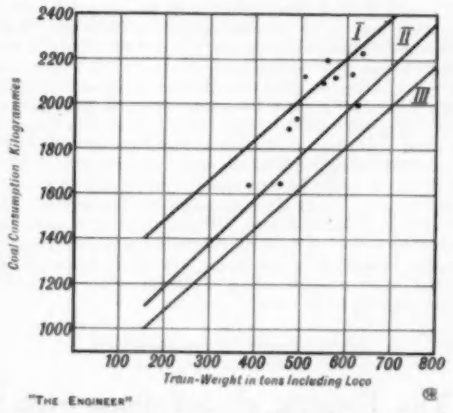


FIG. 15—DIAGRAM OF COAL CONSUMPTION OF LJUNGSTRÖM LOCOMOTIVE

Fig. 16 is a portion of a dynamometer record taken during a run from Stockholm to Upsala. The diagram covers the part of the journey from Väsby to Odensala, a distance of 18 kiloms., or about 11 miles. The uppermost curve of all shows the speed of the train at any point. Next beneath it is the curve of draw-bar pull. The slipping of the wheels at starting is clearly indicated by the oscillations of the draw-bar pull while the train is gathering speed. The effective draw-bar pull is seen to be 11·4 tons, though an extrapolation of the curve drawn by the dynamometer when slipping had ceased shows that, had the the wheels had sufficient grip on the rails, the draw-bar pull would have amounted to 15·2 tons. Beneath the curve of draw-bar pull is that of draw-bar horse-power, which shows corresponding fluctuations as the gradient varies. The maximum speed recorded on the diagram is about 94 kiloms., or nearly 60 miles per hour when the train was descending the 10 per 1000 bank a mile or so north of Rosersberg. Here steam was shut off and both draw-bar pull and draw-bar horse-power descended to zero, the engine coasting till Märsta was reached. The zigzag curve represents the work done on the draw-bar of the locomotive and is to be interpreted as follows:—For every 15,000 kilogram-metres of work done the pen moves vertically across the chart for a distance of 1 mm. The total travel which the pen can make in one direction is 75 mm. Its motion is then reversed and it travels the same distance in the opposite direction. Since the paper is moving forward at the rate of 1 mm. per second, a zigzag line is obtained. Every traverse of the zigzag obviously represents 75 times 15,000 kilogram-metres of work done. In the diagram the distance between two consecutive corners of the zigzag, when the train was going up the 10 per 1000 incline between Väsby and Rosersberg, is found by measurement to be 23 mm. In 23 seconds, therefore, $2 \times 75 \times 15{,}000$, or 2,250,000 kilogram-metres of work were done, and as 75 kilogram-metres per second correspond to 1 horse-power (metric), the engine was developing 1300 horse-power at the draw-bar. When the record is horizontal, as it was before the train ran into Märsta, no work is being done at the draw-bar. Next below the zigzag line is a straight line serving as a time record, the small notches in it being made at intervals of one minute. The profile of the line, which is, of course, drawn by hand, is self-explanatory. It is based on a line drawn automatically by the dynamometer which records distance run, a notch being made on the line at the conclusion of every kilometre. The lowermost curve on the diagram shows the rate of acceleration or retardation of the train at all points of the journey. In studying the diagram it is well to know that the total weight of the train was 663 tons, of which 155 tons was represented by the engine and 508 tons by the carriages.

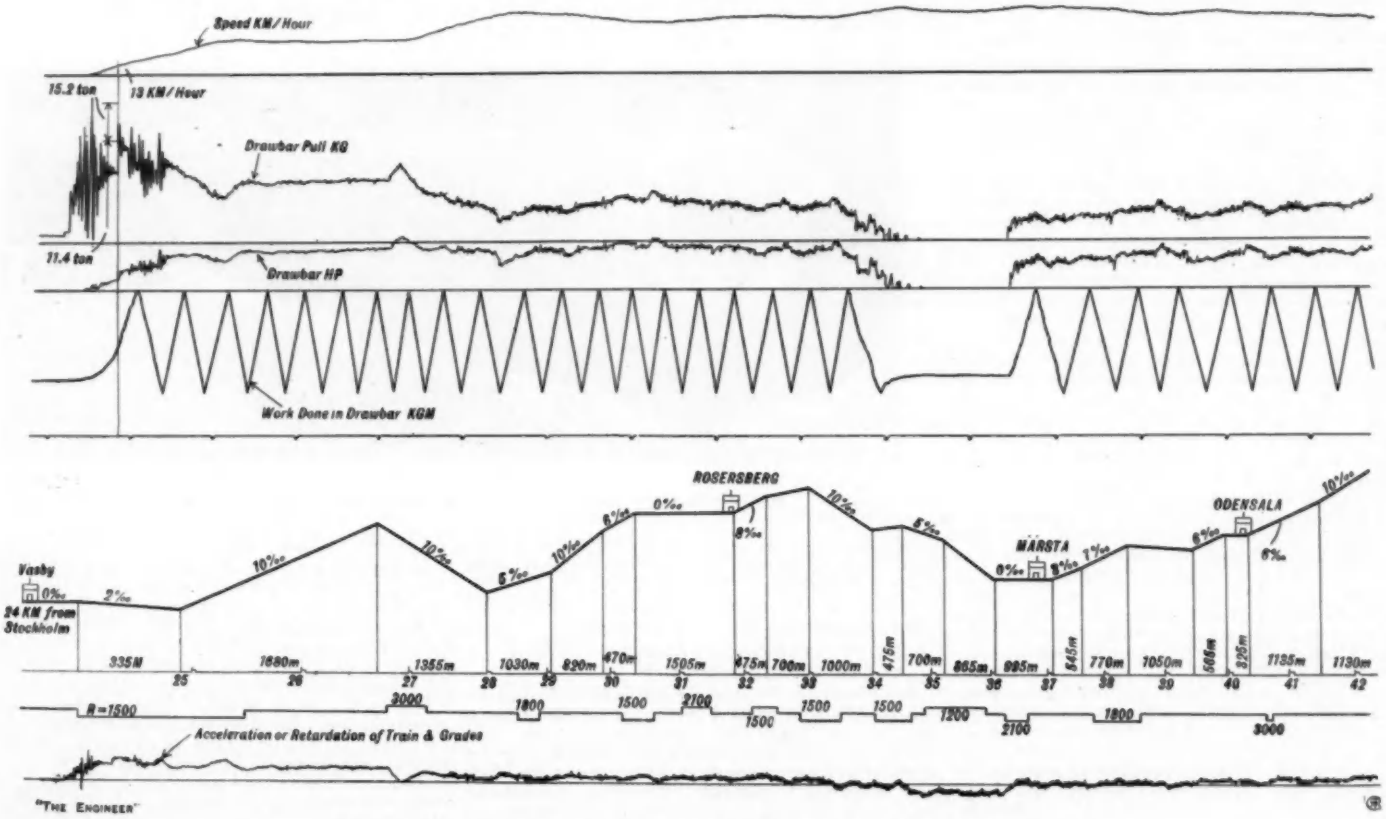


FIG. 16—DYNAMOMETER RECORD OF LOCOMOTIVE ON SWEDISH RAILWAYS

COMPARISON BETWEEN TURBINE AND PISTON LOCOMOTIVES.

Now that the turbine locomotive has definitely entered into competition with engines of the piston type which have held the field unchallenged for a hundred years, it is important that the claims for the new principle should be seriously studied by all engineers responsible for train haulage on steam railways. That the turbine locomotive is very economical in fuel as compared with the piston type for main line traffic has been thoroughly demonstrated, the saving being of the order of 40 per cent. if coal is burnt and 50 per cent. when oil is used. The economy of water is far more striking, the turbine locomotive requiring only about one-twentieth of the water consumed by the corresponding piston engine. In countries where water is scarce or bad for boilers, this is a very important feature. In the Argentine, for example, the piston locomotives have to spend much of their power on hauling water for their own consumption. Figures given by the Railway Authorities show that on a distance of 100,000 kiloms. over the route Clodomira–San Cristobal, the turbine locomotive hauls 29,330,820 more ton-kilometres of paying load than a piston locomotive doing the same work. The value of this extra work, taking freight at 0·025 dollar per ton-kilometre, is 733,270 dollars in favour of the turbine locomotive. Of this sum, no less than 121,525 dollars is accounted for by the water which the piston locomotive has to haul for its own use. Putting the comparison in another way and assuming that equal useful work is done by both the locomotives, the piston engine would require 779 tons more fuel oil and 32,143 tons more water for the 129,974,520 ton-kilometres performed. Since fuel oil cost on an average 52 dollars per ton and water cost 0·20 dollar per ton, the result works out to a saving of 46,980 dollars by utilising the turbine locomotive. The cost of repairs and maintenance of the two types of engine was considered to be equal.

In this connection we may quote a few figures concerning the actual maintenance cost of the Ljungström locomotive now running in Sweden. According to a report by Mr. G. Uddenberg, of the Swedish State Railways, the total maintenance cost incurred between February 3rd, 1927, and July 1st, 1928, during which time the locomotive ran 78,810 km., was 16,200·17 Swedish kroner, or 20·55 öre per kilometre. This cost may be compared with the total maintenance costs of piston locomotives on the same railway system, which, according to the official statistics for 1927, were 23·36 öre per kilometre for the type B locomotives and 21·81 öre for the machines of type F. The running shed charges—comprised in

the above figures—are equally in favour of the turbine locomotive. The latter, with an average mileage of 4600 km. per month for seventeen months, incurred a cost of 6·79 öre per locomotive km. for shed work, as against 7·0 öre for type B piston locomotives running 4000 km. per month and 10·0 öre for type F piston locomotives running 4800 km. per month. These figures, which we believe are the first of the kind which have ever been published, bear out the contention that a properly designed turbine locomotive is at least as economical in maintenance as a standard piston locomotive, and justify Mr. Uddenberg's conclusion that "it is evident that the running expenses of the turbine locomotive, considering that it is a question of a quite new type, have been especially low."

Even in countries where the costs of fuel and water are not of primary concern, the indirect saving due to the elimination of many fuelling and watering points may be considerable. The claims for the turbine principle, however, are not by any means limited to economy of fuel and water. Since a condensing steam turbine will produce power for not much more than half the steam consumption of an ordinary non-condensing piston engine, it follows that with a given size of boiler and fire-box and an equal rate of firing, a turbine locomotive may be built nearly twice as powerful as a piston locomotive, provided, of course, that room can be found for the turbine and gearing. This condition presents no difficulty, and the turbine principle therefore extends enormously the power which may be developed by a locomotive within the limits of the present loading gauge. The high starting torque, moreover, which is characteristic of the turbine enables a turbine locomotive to get away with a heavier train and to accelerate more rapidly than a piston locomotive. The steam consumption at starting is, of course, high, but it falls away very rapidly as speed is gained and conditions become normal. The ease of starting a heavy train is further enhanced by the perfectly even torque which the turbine provides. The mean tractive effort is thus identical with the maximum, a condition which is far from being obtained with a piston locomotive, in which, when a high mean tractive effort is called for, the wheels are extremely liable to slip when the pistons are in such a position that the maximum effort of the cycle is exerted. The turbine locomotive also has no "dead centres" to cause trouble at starting.

THE NON-CONDENSING TURBINE LOCOMOTIVE.

The four Ljungström locomotives which have seen actual commercial service are all of the condensing type, in order to obtain the increased economy and the conservation of water due to condensation of the steam. Although the problem of the air condenser suitable for locomotive service has, as we have shown, been adequately solved, it is, nevertheless, considered by the Ljungström Company that there is a field for the non-condensing turbine locomotive for certain classes of work. In this connection it is interesting to note that when Mr. Frederik Ljungström first investigated the possibilities of applying a turbine drive to locomotives, he worked out a complete design for a non-condensing engine to develop 1800 H.P. A comparison between such a locomotive, and a modern piston locomotive of the same power showed, however, that the economy of fuel which could be obtained was not sufficient to warrant the increased cost of providing a turbine drive. For this reason, the idea was dropped for the time being, and the condensing turbine locomotive developed. The results obtained with the latter, both on the testing machine and in service, showed that the turbine drive was far superior to the piston drive at low speeds, particularly in the range of 30 to 50 per cent. of the maximum speeds. It is in this range that the highest output of power is needed on the road, so that the question of the non-condensing turbine locomotive was again considered by the Ljungström Company, as it appeared likely that even without condensing, a turbine drive might be preferable to a piston drive. Designs for various sizes of locomotive have been fully worked out, and proposals for non-condensing turbine locomotives put before several railway companies. We understand that an order has already been placed for a Ljungström locomotive of this type for service on a Swedish ore-carrying railway, as calculations show that, with exactly the same boiler capacity, pressure and temperature as the standard piston locomotives now in use, the non-condensing turbine locomotive promises a decidedly greater output at the driving wheels over the usual range of working speed. By putting up the boiler pressure from 200 lb. to 228 lb. per square inch and the steam temperature from 640 deg. to 750 deg. Fah.—two advances which present not the least difficulty with a turbine drive—the capacity of the turbine locomotive is about 30 per cent. higher than that of the piston locomotive, and the saving in fuel for equal work is about 20 per cent.

The comparison between turbine and piston drive, both under non-condensing conditions, is still more favourable to the turbine when the locomotives are of very large size. One of the most powerful piston locomotives ever built is the three-cylinder compound "No. 60,000," constructed by the Baldwin Company in 1926. The performances of this engine were fully described by Mr. Lawford H. Fry in a paper read before the Institution of Mechanical Engineers on December 16th, 1927. Working with a boiler pressure of 350 lb. per square inch, it developed a maximum of about 4500 horse-power at the draw bar at speeds from 22 to 37 miles per hour. At a speed of 22 miles per hour, calculations based on a large accumulation of experience by the Ljungström Company show that a non-condensing turbine locomotive built for the same conditions would have an output 50 per cent. greater than that of the piston locomotive, and a steam consumption something like 30 per cent. less per horse-power developed.

Questions of cost, strictly speaking, do not enter into a technical description, but since, for good or ill, cost has to be considered at least equally with efficiency in practical engineering, a line or two on the subject may fitly conclude this article. The first cost of condensing turbine locomotives is always higher than that of piston locomotives of equal power, the extra price being about 60 per cent. for engines of 2000 H.P. and 35 per cent. for those of 4000 H.P. Non-condensing turbine locomotives over about 1600 H.P. can be built for the same price as ordinary locomotives, and larger sizes considerably below the price of ordinary locomotives. These figures, which are based on accurate data and detailed estimates, apply to the manufacture of twenty or more locomotives of the same pattern. Single machines are naturally more expensive to build.

The Forging of Seamless Steel Drums.

By CAPTAIN RONALD BENSON, M.C., B.Eng.

BOILER drums and similar vessels are increasingly being made as seamless forgings, instead of being built up from plates riveted together. There are, however, firms such as Vickers-Armstrongs, Ltd., with which the author is connected, that have been making forgings of this type for some years. The forgings have been used for such purposes as the cracking of petroleum, and for the chemical industries, and are capable of resisting high pressures and temperatures, being similar to the high pressure seamless boiler drums which are now being produced. These notes, based on the experience so obtained will necessarily be platitudes to the practical forgemaster, but may draw attention to some points which are of interest to designers and constructors of high-pressure boiler installations.

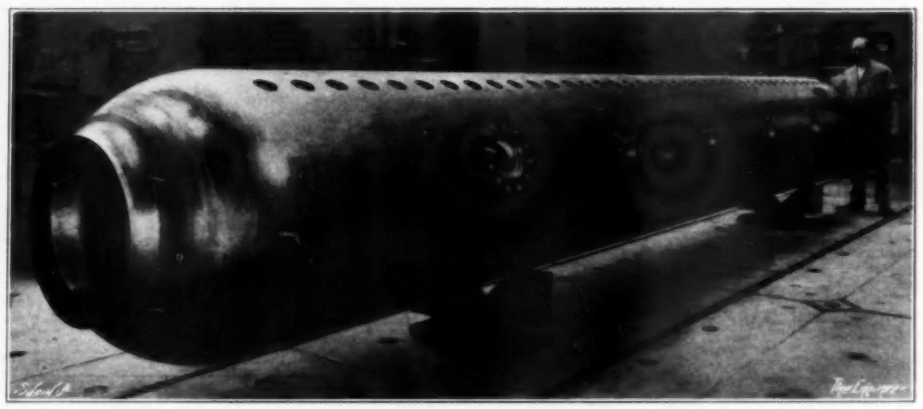


FIG. 1—FORGED HIGH PRESSURE BOILER DRUM CLOSED BY SWAGING

The production of the forgings may be subdivided into two stages, namely :—

(1) The making of an open-ended tube.
(2) The closing in of the ends.

The reason for the second stage is that the interior of a boiler drum, when it leaves the forging press, is irregular and usually by no means free from scale. It has not as yet been considered desirable to put a boiler drum into service with the interior in the black or "as forged" condition. Therefore the interior must be machined, and as that cannot readily be done when the ends are closed in, it is usual to bore the open-ended forging and then to return it to the forge to have the ends closed or "bottled." This divides the forging operations into two distinct periods separated by the intervening machining of the bore.

The chief points of interest in the production of the open-ended forging may now be mentioned.

The first requirement is a hollow billet. This is prepared by trepanning the core from the centre of an ingot, which may or may not have had a preliminary "cogging" or roughing heat in the solid state, and cutting off the scrap ends. The hole thus obtained is usually smaller in diameter than the interior of the required drum, simply for reasons of economy in material.

The hole is next opened out by expanding, or "becking," to use the technical term, to the size needed. In practice, there is a limit to the length of forging which can be "becked" which varies with the plant, and the diameter of the "becking" bar used. The limit will usually be somewhere between 10ft. and 16ft. Greater lengths can only be "becked" with such difficulty as to make the expense prohibitive. It may be assumed that the drum required will generally be greater in length than can be covered by the above limits. The next process therefore will be the forging on a mandrel of the required diameter, so as to increase the length, whilst reducing the wall thickness.

At present the drums needed, have large diameters and thin walls. In the later stages of forging, therefore, the forgemaster is faced by the problem of producing a thin walled tube, on a mandrel of large diameter. The two chief difficulties encountered are the rapid loss of heat and the action known to forgemen as "bellying," which will be dealt with later.

The rapid loss of heat caused by a large mandrel is a serious factor in drum forging. Its magnitude may perhaps be well expressed by saying that the length of a "heat," that is, the length of time during which forging can be carried on after each reheating, varies almost inversely with the diameter of the mandrel, and directly with the wall thickness—*e.g.*, with a 36in. diameter mandrel, working from a billet roughed down to, say, 60in. in diameter, the forging of a tube with a 4in. wall could only be carried on for something between sixty and seventy minutes, according to the nature of the material. If a tube with a 6in. wall were being made, forging could go on for ninety minutes or 100 minutes.

On the other hand, the forging of a tube with a 4in. wall, on a 48in. mandrel, has to be stopped after forty-five to fifty minutes, as the temperature will have dropped in this time below that at which it is economical to continue to forge. Naturally, during the longer periods of forging, greater lengths of tube can be produced, and the cost of forging is, therefore, proportionately lower for the tubes with thicker walls.

Steps which may be taken to reduce the rapid cooling are :—(1) The heating of the mandrel.

A good working rule is that if the mandrel does not "change colour" it is safe to proceed. The most economical method of keeping the mandrel temperature as high as this, is to forge two tubes concurrently on the same mandrel, one being forged whilst the other is being re-heated. This avoids the expense of special arrangements for preheating mandrels.

(2) By the use of hollow mandrels.

A hollow mandrel, the wall of which is 10in. thick, may safely be used. With a mandrel 40in. in diameter this would allow for a 20in. hole, and the volume of metal in the mandrel itself, tending to chill the forging, would be reduced by 25 per cent.

We now come to the action known to forgemen as "bellying." This is the flow of metal when squeezed by the forging tools in a circumferential, as opposed to a longitudinal direction. It is greatly intensified when the tube being forged is a thin one, and is almost absent in large thick-walled tubes, forged on small mandrels. It can be caused, or prevented, to a great extent, by alterations in tool design.

The ideal tools would have only extremely narrow circumferential faces in contact with the forging, so that all the flow would be at right angles to these faces, *i.e.*, in a longitudinal direction. If the face of the tools is too narrow, however, a very large number of squeezes is needed to produce a true cylindrical surface. As a compromise, curved tools with narrow faces and bevelled sides are used.

With such tools "bellying" or sagging off the mandrel is almost entirely eliminated, and the tubes produced are so close to the mandrel that "fast mandrels" are occasionally encountered. This, however, is not a serious drawback, as a few squeezes with the flat tools always suffice to loosen the mandrel again.

In most other respects the production of the straight tubes does not differ greatly from the forging of large gun tubes. The allowance of metal left on the surface of a forged boiler drum for machining varies with the type of furnace and length of time taken in heating, but a rough rule is to allow 1in. on all surfaces, in addition to "mandrel taper" allowance.

There seems to be no reason why boiler drums should not be accepted with a "black forged" finish outside, a little trimming in the machine shop being necessary—in fact, tubes of this nature have been supplied, the interior only being machined, but it is necessary to specify a tolerance of approximately ⅛in. in the thickness of wall. The interior cannot readily be produced sufficiently free from scale to obviate the machining of the inside.

As has already been mentioned, it is usually found to be most expedient to bore a straight hole through the boiler from end to end, and subsequently to close both ends; on the other hand, one end can be (and has been) closed, from the black forging, leaving one end open for machining purposes, to be closed subsequently. The designs now in vogue usually call for a thicker wall on the closed end than on the body or main shell—allowance must be made for this in forging the tube.

The next points of interest are those to be found in closing the ends of the drums.

There are three possible ways of performing this process.

(1) By pressing the end of the forging into a die, as in shell bottling.
(2) By flanging or bending over.
(3) By swaging, the process being similar to the work of the toggle presses sometimes used for closing shells and gas cylinders.

The first method, by using closing dies, is very quick and simple for closing ends where the proportionate reduction in diameter from the main bore, to the bore at the end is small.

Boiler designers, at present, are inclined to specify that the seatings for manholes shall be 16in. by 12in. oval (the standard size), and 17in. by 13in. is the largest size they are prepared to consider at all. Seamless boiler drums are not likely to be in demand with internal diameters much less than 3ft.; hence it can be assumed that the least reduction in diameter required will be approximately one-third of the original diameter. It is quite impossible to carry out such a closing in a "single operation" die. The reason is that the pressure required to close the tapered portion in the die to the extent required is greater than the walls of the parallel portion can support. Even if only the length of the tube exactly sufficient to form the closed end were heated, collapse would take place in the parallel portion where it just enters the die, as shown by the sketch—Fig. 2—and

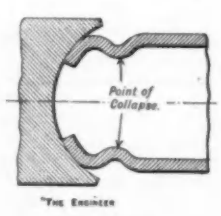


FIG. 2

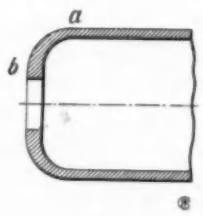


FIG. 3

yet this portion at least must be heated to enable the closing to be made in a single operation.

In practice, a large number of dies, of varying angles, have to be used, the work done in each die being small, and the expense and complication entailed make this method of closing commercially inapplicable for large drums. The closed ends so made are, however, very well formed and evenly stressed in closing.

The second method of closing is by bending over, or flanging. The open ended tube is bored, and rough machined outside. The portion which it is intended to bend over is rough machined for concentricity only, and extra thickness is left on it to suit the design required.

The end to be produced is approximately as shown in Fig. 3. The length of parallel tube required to make the end from *a* to *b* can only be determined by experiment—it is usual, when making the first drum of a new type to close one end only, taking careful measurements, and leaving ample length at the outer end, which can ultimately be cut off when the length needed is known from the measurement of the first end. By this means the length of drum can be regulated with a tolerance of 1in., which is all that designers are asking for at present.

The process, as usually carried out, is to support the drum from below and to bend a small portion of the periphery downwards at the top by pressing on it with a suitable tool. The tube is then rotated slightly, and another portion of the end bent over, so that by the time the tube has been completely rotated the end has been flanged over somewhat, and the diameter of the end of the tube reduced. Care must be taken to insure that the successive applications of pressure are small, and uniform, or an irregular and crinkled surface of the flat end may be produced. With careful handling and avoidance of too low a forging temperature, however, satisfactory flat ends can be produced. It should be mentioned that, in addition to the drum being supported from below, arrangements must also be made to resist the pressure in a longitudinal direction exerted by the closing tool on the drum. When closing is completed, the edge of the hole is slightly irregular and a little machining is needed.

It is not possible to close the end completely by this method.

The advantage of the flat end so produced is that a flat seating for the manhole cover can be made with very little machining. Boiler designers, however, are not altogether in favour of flat ends. There is no doubt that in built-up drums, with flat ends riveted on, the mechanical action known as "panting" which is set up in service, may cause grooving where the ends join the cylindrical shell. It seems very doubtful, however, whether this defect will occur when there is a liberal curvature between the cylindrical portion and the ends, if ample thickness is also allowed for the flat portion of the ends.

The third method of closing is by swaging.

The process is essentially a series of small compressions of the walls of the tube in two places, between the tools, as *a* and *b*—Fig 4.

The effect of one squeeze, with the tube in the position shown, is to thicken the wall at *a* and *b* and to reduce the portion of the tube which is being worked

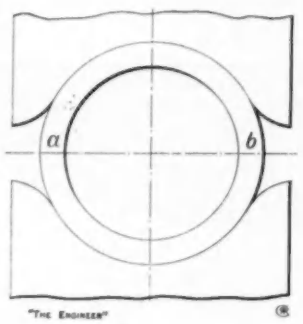


FIG. 4

upon to an ellipse, the major axis of which is the original diameter, the minor axis being reduced by the amount which the press has travelled. If now the tube be rotated, and a series of squeezes be applied, the ultimate result is that the wall is thickened and the diameter decreased.

The first factor to be considered is the longitudinal flow of the metal. There is a tendency during this operation for the portion of the tube which is being worked upon to increase in length, so that the wall thickness is not inversely proportional to the mean diameter as it would be if no longitudinal flow took place. It is not possible to give exact figures as to the ratio of circumferential flow to longitudinal flow, as it depends very greatly upon the design of the tools employed and the method of manipulation, but it has been found that with unsuitable tools the wall thickness of the tube may even be less after the diameter has been reduced than it was before.

This ratio, however, must be known before the amount of metal to be left on the thickened end of the tube for closing can be determined. Also, the longitudinal extension of the dome portion must be allowed for, so that the drum shall be of the correct length when closing is completed. It is usual to allow a tolerance of 1in. on the overall length of the drum after closing, and it has been found possible to work within this tolerance for a drum 45ft. long.

Special tools are needed to shape the domed end of the drum unless a considerable amount of machining is to be done on the exterior after closing, and such tools are only applicable to a drum differing very little in size from that for which they are designed.

It is not practicable to produce a drum with a flat or slightly dished end by this method of closing, the easiest shapes of end to produce, and therefore the cheapest, being either hemispherical—Fig. 5—or

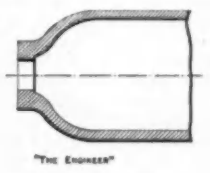


FIG. 5

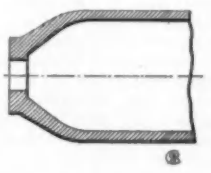


FIG. 6

conical—Fig. 6—with a protruding spigot which is machined inside to form a seating for the manhole cover, the length of spigot desirable being 3in. to 4in. with a 4ft. drum.

The wall thickness of the domed end can quite readily be increased to any desired amount at the will of the designer, in fact, the thicker domes are, if anything, slightly easier to produce, so that the designer can call for an end which he is sure is much stronger than any other part of the boiler.

It may be mentioned that seamless vessels intended for oil cracking, with a 2ft. bore, have been produced with one end closed down till the only trace of the original 2ft. bore to be seen was a small line which did not extend beyond a circle 2in. in diameter, and the ends were closed, after boring, by a screwed plug only 3in. in diameter. The ends in this case were closed by swaging.

The photograph, which is reproduced in Fig. 1 by the permission of Vickers-Armstrongs, Ltd., shows a boiler drum, the ends of which have been closed by swaging. The domed end and the protruding spigot are clearly shown.

The Churchill Harbour Terminus of the Hudson Bay Railway.

By the end of March last the railhead of the Hudson Bay Railway was now within a few miles of the terminus, Churchill Harbour. The barren area in the region of Hudson Bay had been traversed and the rails were being laid through a bush country with scattered muskegs along the Deer River. Following the arrival at the terminus, however, much work will require to be done on the docks and port facilities before freight shipments will be possible. It has been estimated that a year's intensive work will be needed before grain shipments can be accepted. Meantime the situation is being carefully investigated by the big western wheat interests and the grain companies with the view to providing elevators and shipping facilities. Development along that line is expected to be rapid when once the railway is in a position to supply a service to the port.

Plans for the Hudson Bay Railway assumed definite shape in 1910, when a branch line of the Canadian Northern Railway was completed from Hudson Bay junction, on its Winnipeg–Prince Albert section, to The Pas, on the Saskatchewan River, and the building of a Government line from The Pas to Hudson Bay was authorised by Parliament. Work on the Hudson Bay Railway was commenced the following year, with Churchill as its objective. The proposed route lay entirely to the north of Nelson River, and measured 474 miles. A site for a town had been surveyed at Churchill in 1908, and it was confidently expected that this natural port would be developed in the course of a few years. Before much progress had been made on the building of the railway, or any work done at Churchill other than surveys, however, the Government of the day decided to make Port Nelson the terminus of the line in place of Churchill. The location of the railroad was altered accordingly. The new survey crossed the Nelson River twice, once at Manitou Rapids and again at Kettle Rapids. The route was shortened by 50 miles, as compared with that to Churchill, the total distance from The Pas to Port Nelson being 424 miles, but the developing of harbour facilities at the newly selected port involved greater efforts than at Churchill.

The right of way was cleared and graded to Port Nelson, and rails were laid before the end of 1918 as far as Kettle Rapids, 332 miles from The Pas. A very substantial steel bridge of a single 1000ft. span was erected at this crossing of the Nelson. Expenditures on the building of the railway amounted to 14,000,000 dollars, while 6,000,000 dollars were spent on port development at Nelson. Owing to the war and the consequent lack of men and materials, operations were suspended before the project was completed, and for some years only part of the finished railway was kept in repair.

In 1926, however, the work of completing the line was actively resumed by the Government. During the eight-year interval between the closing down of the work and the resumption of construction, Nature had rendered useless much of the work that had been done. The sleepers had rotted and acquired replacing; the right-of-way had been badly damaged by successive frosts, and embankments had settled. Before additional construction could be undertaken, it was necessary to rehabilitate the entire mileage as formerly constructed, and that was done by the construction forces of the Canadian National Railways.

The resumption of work on the line made it necessary either to confirm the choice of Nelson as the terminus of the road or to reconsider the situation. In that connection a Special Committee of the Upper House of Parliament had recommended that, before making further important expenditures at Nelson, a new and thorough examination into the relative merits of Churchill and Nelson should be made. No authority on harbour development had previously been consulted in relation to Hudson Bay ports, and Mr. Frederick Palmer, of Rendel, Palmer, and Tritton, of Westminster, was engaged by the Government to investigate the respective merits of the two ports. Concurrently, steps were taken to ascertain whether it was physically possible to construct a line to Churchill, doubt having been thrown on that question by engineers who had favoured the selection of Nelson.

After close investigation by competent engineers, it was found that it would be no more difficult to construct a line of railway to Churchill than to Nelson. In August, 1927, Mr. Palmer, together with the Minister of Railways and Canals and the chief officials of the department, visited both places, and on their return Mr. Palmer reported that Churchill was undoubtedly the port that should be selected, since it afforded an excellent harbour in which shipping facilities could be provided in calm water, protected from all storms by the surrounding cliffs. In his report, Mr. Palmer put forward estimated costs of corresponding accommodation at Nelson and Churchill which showed that, including interest during the period of construction, the cost at Churchill will be less than one-third of what would be required to complete

the work at Nelson. Even after adding the cost of the extra 87 miles of railway to Churchill, the cost of developing a port at the latter point would be only about one-half of the Nelson estimate. Furthermore, it was stated also that the annual charges, including interest, operation and maintenance, would be about a million dollars greater at Nelson than at Churchill. An important consideration was the fact that approach to Nelson of vessels of 28ft. draught would be limited to a brief period round about high water at neap tides, unless much expenditure were incurred in dredging, whereas, at Churchill, accommodation could readily be provided to admit of 28ft. draught vessels during twenty-four hours of each day.

In consequence of this recommendation by such an acknowledged authority on harbour problems, it was decided to extend the railway to Churchill and to establish the Hudson Bay Railway terminus at that point, which, as a matter of fact, was the terminus named in the instructions to the engineers in charge of the original surveys of twenty years ago.

Last year good progress was made in the construction of the railway to Churchill. The grading and ditching of the Churchill extension was let to contract, while the track and station work is being carried out by Canadian National's construction forces. At the height of operations during the 1928 season, 2200 men were employed on the line with equipment that included three steam shovels, a track-laying machine and twelve locomotives. During the summer about 16,000 tons of material were sent in by sea from Halifax and Sydney, and unloaded at Churchill. Two dipper dredgers, "Churchill No. 1" and "Churchill No. 2," built at Montreal especially for the work, and a hopper barge, the "Chesterfield," built at Collingwood, Ontario, were delivered at Churchill late in September, and are now being used. A second hopper barge, acquired from the Department of Marine and Fisheries, was taken into Port Nelson and towed to Churchill.

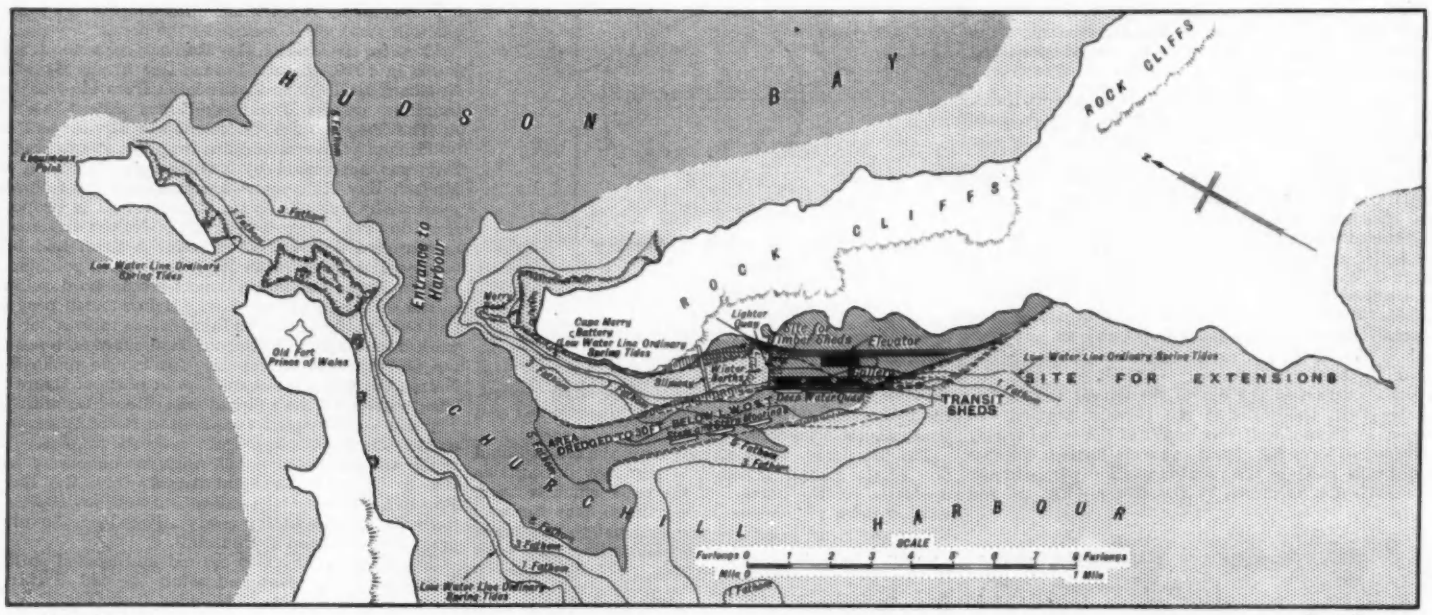
On the operations at Churchill, 349 men were employed during the season, and the work was materially expedited by the use of airplanes between Churchill and railhead. A good deal of useful information in connection with the navigation of Hudson Bay and Strait was secured by an aerial expedition established by the Department of Marine and Fisheries at three points on Hudson Strait. As a result of the expedition, steps will be taken by the Department of Marine to establish at strategic points throughout the Strait modern aids to navigation, including direction-finding devices, which will be of invaluable assistance to navigators in those northern waters, and will add greatly to the navigating possibilities of the route.

At Port Churchill nature has provided magnificent breakwaters, consisting of rocky cliffs rising to heights of from 40ft. to 70ft., enclosing a harbour 6 miles n length and from 1 to 2½ miles in width at low water and 1½ to 4 miles at high water. The entrance to the harbour consists of a narrow gap between these headlands with a low water width of 1600ft., a width of 850ft. at 30ft. depth and 750ft. of width having depths exceeding 60ft. Inside the entrance there exists an area of 140 acres with depths of 30ft. and over at low water, and a further area of about 180 acres with depths varying from 18ft. to 30ft. at low water, beyond which, as already indicated, there is an extensive area of lesser depth.

The position chosen for the wharf is in a completely sheltered part of the harbour, and it is considered to be an ideal site in every way. Borings taken and trial pits excavated disclosed the fact that the bed consists of gravel and sand with some clay and some boulders. It is of a nature easily dredged, and the engineers have reported that it will be a simple matter to dredge a channel 30ft. deep along the wharf front and to connect it by a channel of the same depth, 600ft. wide, to the 30ft. contour depth line at low water inside the harbour.

There is a large area of land, at a suitable level immediately adjoining the site, on which railway terminal facilities will be provided. Access to the wharves is easy from the terminal yard, not only for future working but also for constructional purposes, while access from land to wharf extends over the whole length. There is ample room, therefore, for dock facilities, transit sheds, grain elevators, railway lines, &c., and for the efficient handling of all traffic. Material for constructional purposes, such as rock, gravel and sand is available in almost unlimited quantities within a mile of the works.

The works at Churchill will be carried out in a sheltered situation. No roughness of weather can sensibly affect the progress of either construction works or dredging. Under these conditions, three years has been assumed as a safe time for the carrying out of the works, which is one-half of the time which would be required at Nelson. The site of the wharf has been so laid out as to admit of easy, and, for all practical purposes, unlimited extension along the east shore of the harbour. About twenty vessels could be berthed in one straight line, with moorings for twenty more, and that would not by any means exhaust the possibilities of extension.



PLAN SHOWING THE HUDSON BAY RAILWAY TERMINUS IN CHURCHILL HARBOUR

The Testing of Porcelain Insulators.

THE overhead power line work that is being carried out in this country is causing engineers to pay attention to matters which received relatively little consideration in the past. The testing of porcelain insulators, for instance, has become a matter that concerns a considerable number of men engaged in the electrical industry, and there is no doubt that the paper which Mr. B. L. Goodlet read on this subject before the Institution of Electrical Engineers on April 11th will be widely appreciated. In this country, where overhead line work is more or less a new development, or at any rate a class of work with which many British engineers are none too familiar, papers of this nature are needed. The tests on insulators now in vogue are often carried out in a very unsatisfactory manner, whilst the results are subjected to all kinds of misinterpretations. Moreover, some of the tests required even in national insulator specifications, do not reveal that intimate knowledge of conditions in the testing-room and in service which is so desirable. There are various things that govern the service performance of insulators which the tests called for in the standard specifications do not adequately take into account. Insulator troubles on transmission lines may arise owing to excessive voltages, reduction in insulation strength, and mechanical failures. Excessive voltages may arise owing to surges, caused, for instance, by the sudden dropping of load, switching surges, and arcing earths, or lightning surges. But experience has apparently shown that in systems insulated in accordance with modern practice, with the neutral earthed, lightning is the only source of over-voltage that requires serious consideration. Although voltages induced in the line by lightning are of an impulsive nature, oscillatory voltages may be built up, and it may therefore be concluded that from the over-voltage standpoint, the impulse and high-frequency characteristics of the insulator are of first importance. The grading of the insulation strength of various parts of a transmission system is a matter that has given rise to a large amount of consideration as the result of the over-voltage problem, and with the object of ensuring that troubles will occur at a point convenient for repairs, a short section of the line immediately adjacent to a station has frequently been more lightly insulated than other portions of the system. Station apparatus insulation may either increase continuously from the incoming line to the main transformers, or the relative strength may be graded on a basis designed to attain the minimum number of interruptions, minimum cost of repairs, or some other object. But while the adoption of some such scheme appears to offer material advantages, the basis of classification to be adopted requires careful consideration.

As lightning trouble is the principal reason for the introduction of these schemes, many argue that the lightning or impulse spark-over and puncture voltages of the component parts should be made the basis of the grading. On this basis classification calls for the standardisation of methods of carrying out the impulse test especially with regard to the wave form of the impulse adopted. The wave form should obviously approach as closely as possible to that of the disturbance caused by the lightning, but, unfortunately, a "standard" lightning surge does not appear to exist. Although the wave shape of an impulse arriving at the station from the line may be perfectly simple, and well known, by the time it has traversed the various choke coils, isolators, oil switches, current transformers, &c., its character may be considerably changed. The voltage developed at the main transformer terminals may often, in fact, be oscillatory. Hence it seems that, until further information is available, it would be unwise to make far-reaching alterations in the specifications, such as the classification and rating of insulators on the basis of impulsive performance would involve. Although investigation may prove that the characteristics of the dangerous disturbances are sufficiently definite to enable imitative tests to be standardised, at the moment this is a matter of doubt. A reduced spark-over voltage or a reduced puncture voltage may serve as a manifestation of a reduction in the insulation strength of a system. Adverse surface conditions, such as rain or fouling or mechanical damage, such as fracture of the insulator sheds, may cause a reduction in the spark-over voltage, but as the impulse and high-frequency spark-over voltages are unaltered by rain and fouling, surface conditions only become important when the reduction is so great that the normal operating voltage can start trouble. As with systems insulated in accordance with present-day practice a reduction of such magnitude can only be effected by fouling, a study of the phenonema of fouled insulators is one of no small importance. Almost invariably a reduction in the puncture voltage is attributable to some mechanical defect, although cumulative damage may occur as the result of repeated impulses. Excessive electro-mechanical loading, swelling of cement, the growth of metal parts by corrosion and sudden temperature changes are all liable to give rise to a reduction in the puncture voltage, and for all these troubles it is difficult to devise satisfactory tests. Occasionally, mechanical troubles occur owing to abnormal operating con-

ditions, but as a rule they can be traced to faulty design or defective manufacture. Inefficient packing also seems to have been the cause of trouble in the case of insulators that have been shipped to distant parts. Whilst the most obvious constructional defects which give rise to a low ultimate strength are taken care of by the ordinary mechanical load tests, there are other points which call for special consideration.

Franco-Italian Railway Between Nice and Coni.

THE new international railway connecting Nice in France with Coni in Italy was opened for public service on October 31st last. This line fills a long felt want, as it provides direct railway communication between Turin and Northern Italy and the French Riviera, and—by means of a branch line between Breil and Ventimiglia—the Italian Riviera as well. Our contemporary, *le Genée Civil*, gave an excellent illustrated description of this new line in its issue of November 3rd last, and in what follows below we give a *résumé* of that description, which is from the pen of Monsieur G. Blot, Ingénieur Principal of the P.L.M. Railway Company.

The undertaking had been long under consideration and under construction. Between 1882 and 1900 the Italians had built a line between Coni and the Col de Tende, just north of Viévola—see Figs. 1 and 2—

FIG. 1—RAILWAYS IN FRANCE AND ITALY

and they were desirous of continuing it to Ventimiglia on the coast by way of the Valley of the Roya, which afforded the easiest and most natural route. To do so, however, involved the traversing of some 18 kiloms. of French territory, passing through the Communes of Fontan, Saorge and Breil. That necessitated the arrangement of an agreement between the two countries, which took some little time to arrive at, but eventually an international convention for the establishment of direct railway connection between Nice and Coni and between Coni and Ventimiglia was signed by representatives of the two Governments in June, 1904. This Convention ,which was ratified in France by the law of March 20th, 1906, provided that France should build on her own territory a line of railway uniting Nice with the Italian railway system in the direction of Coni by way of Sospel, and also a branch leaving the main line at Breil in order to connect up with Ventimiglia by way of the Valley of the Roya. The convention also stipulated that the line should pass from the Valley of the Bévéra to that of the Roya by means of a tunnel under Mount Grazian. The management of the lines in French territory was given to the P.L.M. Company.

The total length of the lines in French territory is 63·164 kiloms., of which 58·767 kiloms. represent the length between Nice and the northern Italian frontier, and 4·397 kiloms. that between Breil and the southern Italian frontier. The lines are single throughout, saving that the tunnels have been made large enough for two sets of metals to render ventilation easier. The maximum gradient is 25 per 1000, or 1 in 40, and the minimum radius of the curves is 300 m.—or nearly 15 chains.

The main line, of which a plan and a profile are given in Figs. 2 and 3—starts from the P.L.M. Station at Nice at an altitude of 15 m. It passes above the Carabacel Tunnel, and then, turning towards the north, passes through the station of Nice-Saint-Roch, mounts up the Valley of the Paillon, passes La Trinité-Victor, crosses the river Paillon twice, then after running through Drap, Peille, and Touet de l'Escarène, passes under the Col de Braus, by the longest tunnel on the line—5939 m., or nearly 3¾ miles—proceeds through Sospel, crosses the Bévéra torrent by a steel viaduct, then passing in tunnel from the Valley of the Bévéra to that of the Roya under Mont Grazian it finally reaches Breil, at an altitude of 305 m., where junction is made with the railway coming from Ventimiglia.

Beyond Breil the route lies up the Valley of the Roya, the deep gorge of which is crossed twice, first of all

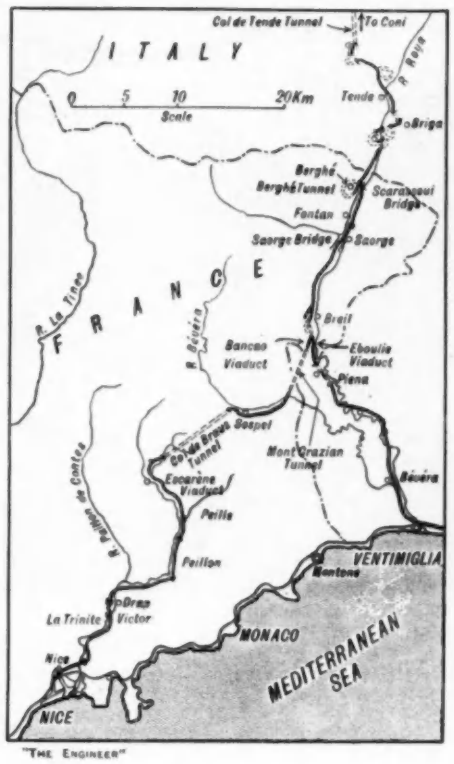


FIG. 2—THE NICE-CONI RAILWAY

at a height above the stream of 60 m. by a masonry bridge at Saorge ; and secondly, at a height of 42 m., by another masonry bridge at Scarassoui. Finally, after passing round a loop, which embodies the helical Berghe Tunnel—1885 m. in length—the line connects up with the Italian railway system at an altitude of 600 m.—nearly 1970ft. The Ventimiglia branch starts from beside the passenger station at Breil, runs at first alongside the line from Nice, then passes under it in tunnel, enters and descends the Valley of the Roya, and reaches the frontier at an elevation of 226 m.—a drop of 79 m. in 4·397 kiloms.

In all, there are no fewer than forty-five tunnels—forty-one of which are on the main line—of an aggregate length of 23·6 kiloms or about one-third of the total length of the line. Four of these tunnels are of important dimensions. There is, first of all, that under the Col de Braus, which, as has been said, is nearly 3¾ miles long, and is the longest tunnel for two lines of railway in France. Then come the Mount Grazian Tunnel, 3887 m. ; the Berghe Tunnel, 1885 m. ; and the Gigne Tunnel, 1188 m., the last named being on the branch line.

Constructional work was begun as long ago as 1909, and was only completed last year. The long duration of the operations is partly explained by the intervention of the war, and partly by the fact that finance was difficult in the post-war years. Considerable delay was also caused by the nature of the materials passed through in driving some of the tunnels. In the case of the Braus Tunnel, for example, a stretch of anhydrite, 1000 m. in length, was encountered. Anhydrite is anhydrous sulphate of calcium, which by the absorption of two molecules of water, is converted into gypsum, swelling considerably in the process. Some time before the war broke out a heading, having an upward slope of just under 1 in 100, had been driven through the deposit of this material

FIG. 4—CONI PORTAL OF TORETTE TUNNEL

into a deposit of lime stone beyond it, and, when excavated, the rock was quite dry. It was still in that condition when operations were stopped in 1914 on account of the hostilities. In 1919, however, when it was decided to resume work, instead of finding the sound dry rock left in 1914, rock saturated with water, swollen and disintegrated was discovered. In fact, some of the anhydrite is described as having behaved much in the same way as does a book when opened, the leaves spreading out fanwise, thus permitting moisture to penetrate still further in between the laminæ.

Experience with anhydrite had been obtained many years previously when driving the Gènevreuille

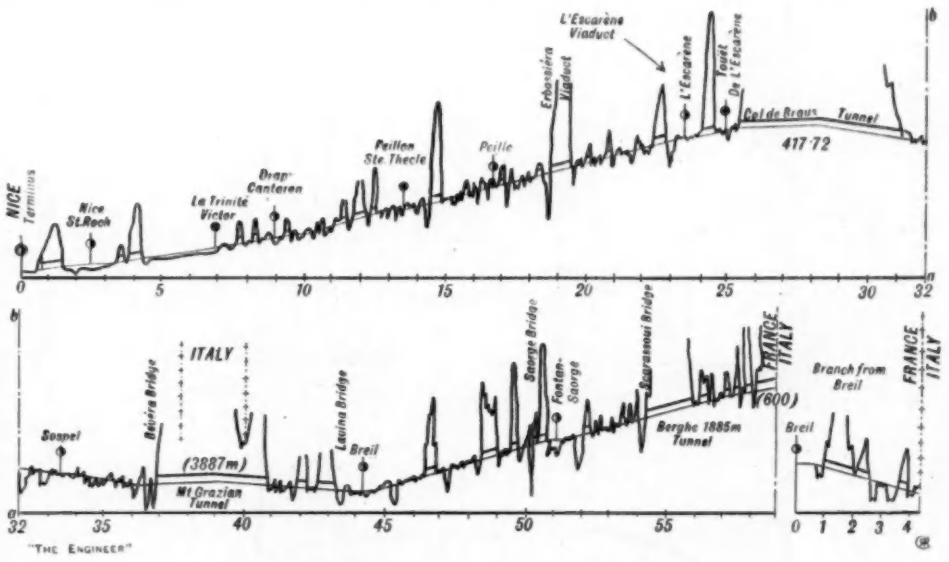
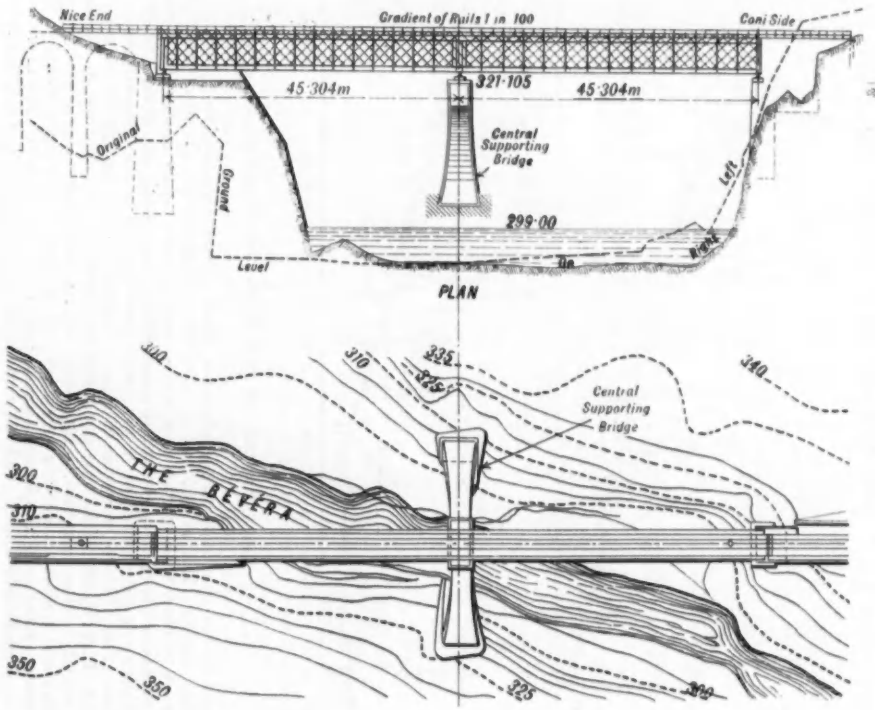
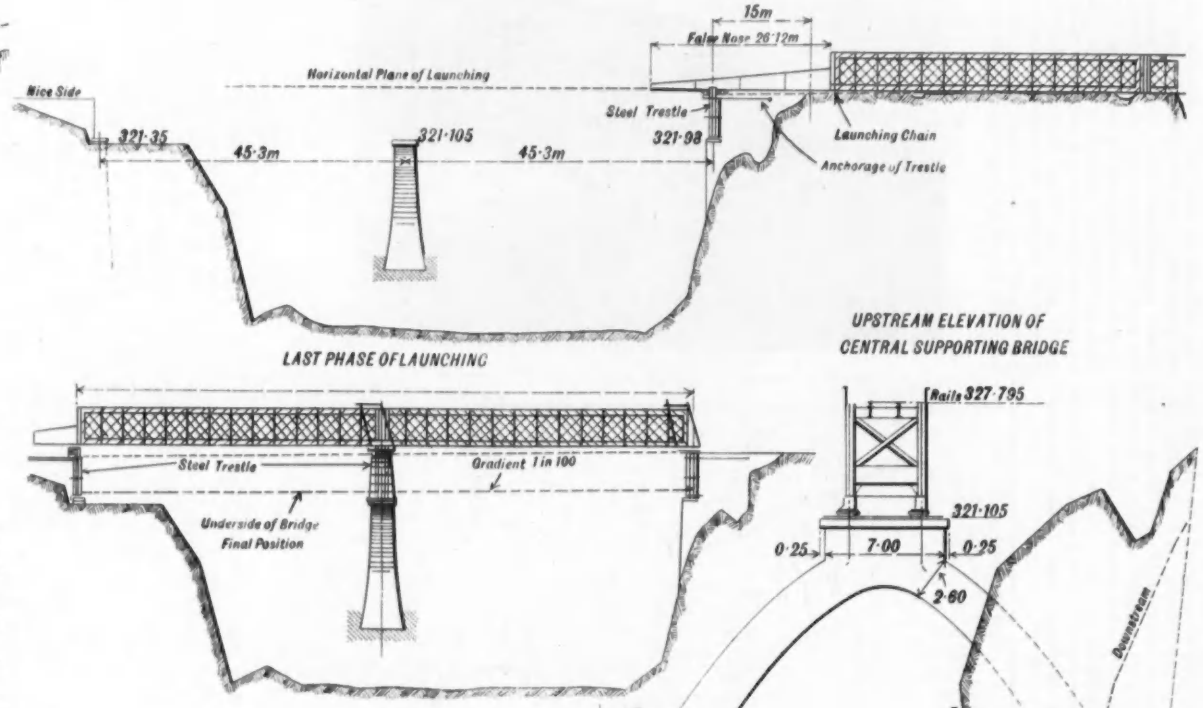


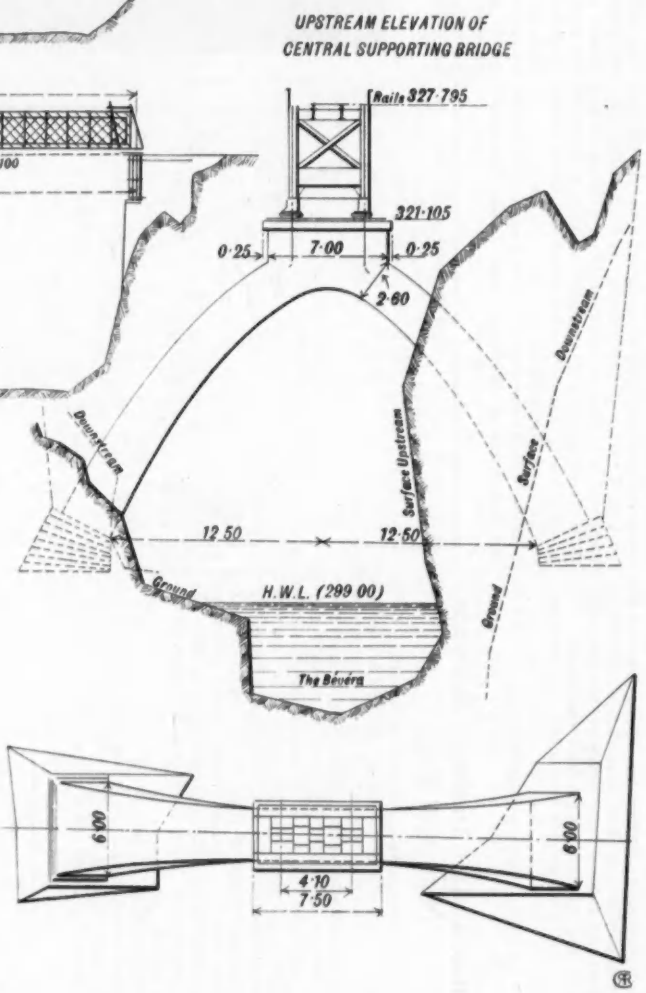
FIG. 3—PROFILE OF THE NICE-CONI RAILWAY

Tunnel between Vesoul and Lure on the line from Paris to Mulhouse. It was there found that it was necessary to make special arrangements to drain away, as efficiently and quickly as possible, the water met with, and to take special precautions to prevent the formation of the gypsum as well as to counteract its effects should it be formed. In the Braus Tunnel even more elaborate measures than those taken in the Gènevreuille tunnel had to be resorted to, since there was a good deal of water coming down—some 220 litres per second, or at the rate of over 4 million gallons per twenty-four hours. What was done is described at some length by our contemporary, and we would refer those of our readers who

NICE-CONI RAILWAY—BRIDGE OVER THE RIVER BEVERA

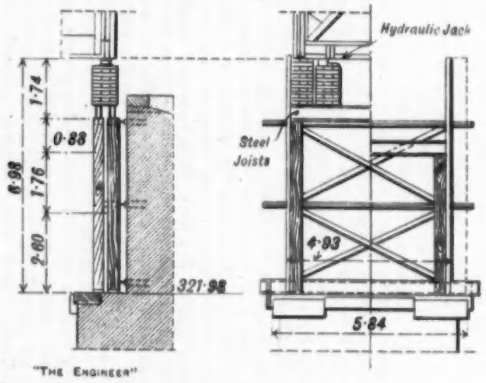






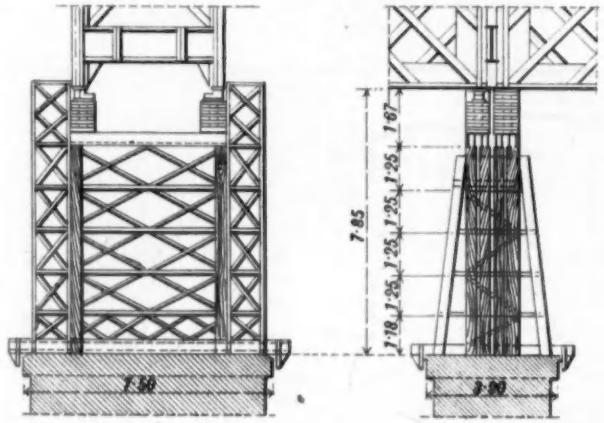
LOWERING THE BRIDGE ON TO ITS SUPPORTS

ARRANGEMENTS ON ABUTMENTS



"THE ENGINEER"

ARRANGEMENTS ON CENTRAL SUPPORTING BRIDGE



are interested in the question and require further information regarding it, to the article from which we are quoting. The measures taken were successful, but having to take them caused delay.

Apart from the tunnels, the line is noteworthy on account of the numerous bridges which had to be built across the many valleys and ravines that had to be crossed. There are in all more than 200 bridges in steel, masonry or reinforced concrete. Forty of them, which embody spans of 10 m. or more, represent a total length of more than 3 kiloms. The principal steel structures are :—(*a*) The Bévéra viaduct ; (*b*) two bridges over the Paillon ; (*c*) a bridge at Trinité-Victor with three openings with spans of

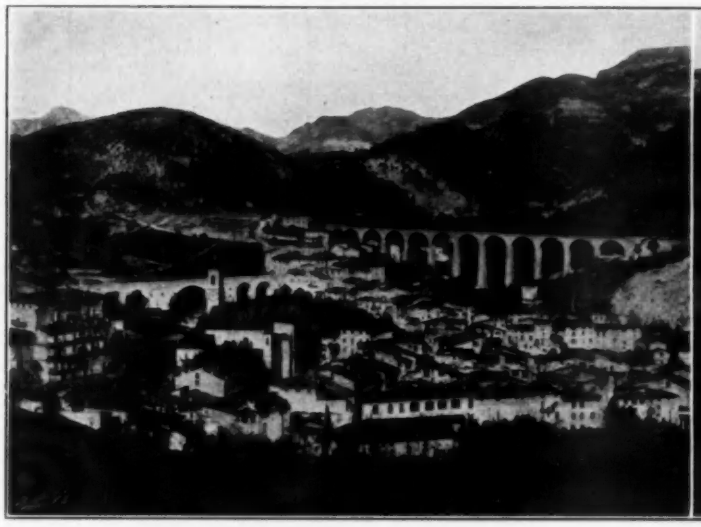


FIG. 5—ESCARENE VIADUCT

FIG. 6—ERBOSSIERA VIADUCT

28·7 m. and 31·57 m.; and (*d*) the Pont des Vernes with four openings with spans of 26·09 m. and 28·46 m. Then there is a reinforced concrete bridge over the Paillon, which has an opening of 61 m. Of masonry structures there are twenty-two viaducts, the arches of which have spans varying from 6 m. to 36 m. Noteworthy among them are (1) the Erbossiéra viaduct—Fig. 6—which has one span of 10 m., nine of 8 m. span, with an intermediate arch of 36 m. span ; (2) the Escarène viaduct, with eleven arches of 15 m. span ; and seven single arch bridges with spans of from 14 m. to 48 m., among which the Saorge bridge —40 m.—and the Scarassoui—48 m.—are discussed in greater or less detail by our contemporary. We, however, propose only to deal at any length with one —namely, the Bévéra bridge—which presents features of more than usual interest. The methods employed in its erection were also noteworthy.

The line laid out for the railway passed over the Bévéra Torrent, at the site chosen for the bridge, at a very acute angle and to have crossed the stream in one span would have necessitated the use of a bridge over 91 m.—or nearly 300ft.—in length. Not only would that have meant the employment of a much heavier structure than that actually installed, but the difficulties of erection would also have been greatly enhanced. The employment of a central support, however, considerably simplified the problem, but it was impossible to use a plain pier for the purpose, for it would have had to be erected right in the centre of the stream, which was not very wide. The ingenious plan of building a subsidiary bridge to form the central support was, therefore, resorted to. The arrangements are illustrated on page 430. As will be observed from the drawing in the right-hand lower corner, this subsidiary bridge is an ogival arch structure, the erection of which was comparatively easy. It was built of masonry and carries at the crown of the arch a platform measuring 7·5 m. by 4·1 m., which constitutes the central support for the main bridge.

Monsieur Blot goes in great detail into the construction and getting into position of this main bridge, but we ourselves shall only describe the proceedings in outline, though in a manner that will, we trust, be readily understood by the aid of the drawings. The bridge is of steel and of the lattice type with a single line of rails arranged on the top platform. The materials for its construction were received from Ventimiglia by way of Breil, and the launching had, therefore, to be effected from the Coni side. The length of the bridge is 91·19 m. and it was arranged that the structure should be built up on the railway road bed, As a length of only 65 m. was available for the purpose. the building up had to be effected in stages. In the first instance fifteen panels of the bridge were riveted up so as to constitute rather more than half the total length. As finally fixed in position the bridge has a down gradient of 1 in 100 towards Nice, but it was launched with the truss horizontal. The different stages of mounting and launching were then as follows :

(*a*) A steel trestle was erected on the Coni abutment—see the drawing at the right-hand top corner on page 430—so as to form the first support of the bridge as it was launched ;

(*b*) The mounting of a false nose in four detachable portions, the total overhang being 26·12 m.;

(*c*) The rigging on the trestle of swinging beams and rollers for the launching ;

(*d*) The first launching operation which brought the front end of the bridge to a point 15 m. beyond the abutment. The advance of the bridge was effected by means of two winches, one on each longitudinal boom of the bridge, fixed at the rear, each winch hauling on one end of a chain, the other end of which, after being led over a guide pulley, was brought back and anchored to the abutment ;

(*e*) Adding a further portion of the bridge—nine panels—at the rear ;

(*f*) The second launching operation, which brought the front end of the false nose over the centre support ;

(*g*) Building trestles on that support and rigging swinging beams and rollers, as in the Coni abutment, using the bridge and false nose for taking forward the necessary materials and putting them in position.

At this point Monsieur Blot breaks off his account to explain that it was considered that the longitudinal thrust resulting from forcing the bridge forward by the operation of the winches might deleteriously affect the stability of the central support. Accordingly, the rollers on the support and on the Coni abutment were furnished at their ends with toothed wheels working in connection with hand-operated levers fitted with pawls, by means of which the rollers could be revolved step by step, their speed of revolution being made to synchronise with the rate of advance of the bridge. The next step—

(*h*) was the adding of the final panels of the bridge, and the fixing at the rear ends of the longitudinal booms of temporary brackets—the purpose of which will be explained later. The bridge was then launched still further forward, so as to bring the front end of the false nose above the abutment on the Nice side ;

(*i*) Trestles and launching gear were then arranged on that abutment and the same procedure, as carried out at the central support, repeated ;

(*j*) The bridge was then further advanced until its forward end came immediately over its final resting point ;

(*k*) The three forward portions of the false nose were then removed, leaving only the fourth portion in position, so that it might be used, in conjunction with the brackets at the other end of the bridge—of which mention was made above—during the operations of lowering the latter on to its supports.

(*l*) Finally, the swinging beams and rollers were removed and the wedges and jacks to be used in the lowering got into position.

It has already been explained that the bridge was launched in the horizontal plane and kept horizontal during the whole period of the advancement. It has also been said that, as finally erected, it has a down gradient in the direction of Nice of 1 in 100. Furthermore, as the rails are on the top platform, and as the bridge was built on the road bed, it was necessary to lower it through a depth just more than the depth of the bridge structure, in order to bring its rails to such levels as would enable them to be jointed up with the rails on the approaches at both ends. The actual heights through which the ends of the bridge had to be lowered were 6·20 m. at the Coni—or launching—end, and 7·10 m. at the Nice end.

The operation was carried out in successive stages, first of all at the central support, and then, alternately, on the Nice and Coni sides. The distances

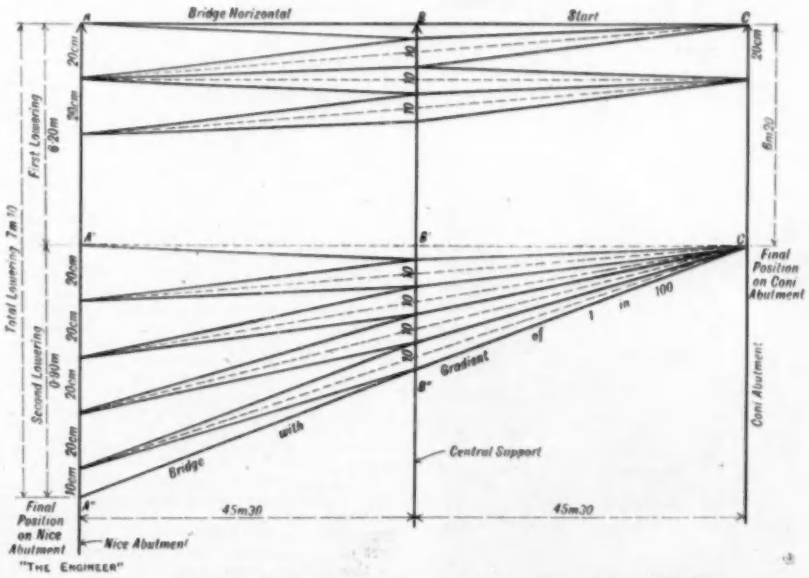


FIG. 7—DIAGRAM SHOWING STAGES OF LOWERING BRIDGE TRUSS

lowered through in the first few stages were as follows :—

1.	On the Central Support	0·05 m.
2.	„ Nice abutment	0·20 m.
3.	„ Central Support	0·10 m.
4.	„ Coni abutment	0·20 m.
5.	„ Central Support	0·10 m.
6.	„ Nice abutment	0·20 m.

and so on in regular stages till the Coni end had been lowered through 6·20 m., and the bridge was horizontal, as shown by the line $A^1 B^1 C$ in Fig. 7. It then remained to lower the Nice end another 0·90 m., and that was effected in stages, of which the first were :—

1.	On the Nice abutment	0·20 m.
2.	„ Central Support	0·10 m.
3.	„ Nice abutment	0·20 m.
4.	„ Central Support	0·20 m.

and so on till the bridge reached its final position and

had a gradient of 1 in 100. The lowering was effected by the aid of 50 and 100-ton hydraulic jacks.

We can do no more than mention briefly some of the principal masonry structures. First of all, reference may be made to the Escarène Viaduct—Fig. 5—which carries the line over the Redebraus Torrent. This viaduct, which has a maximum height of

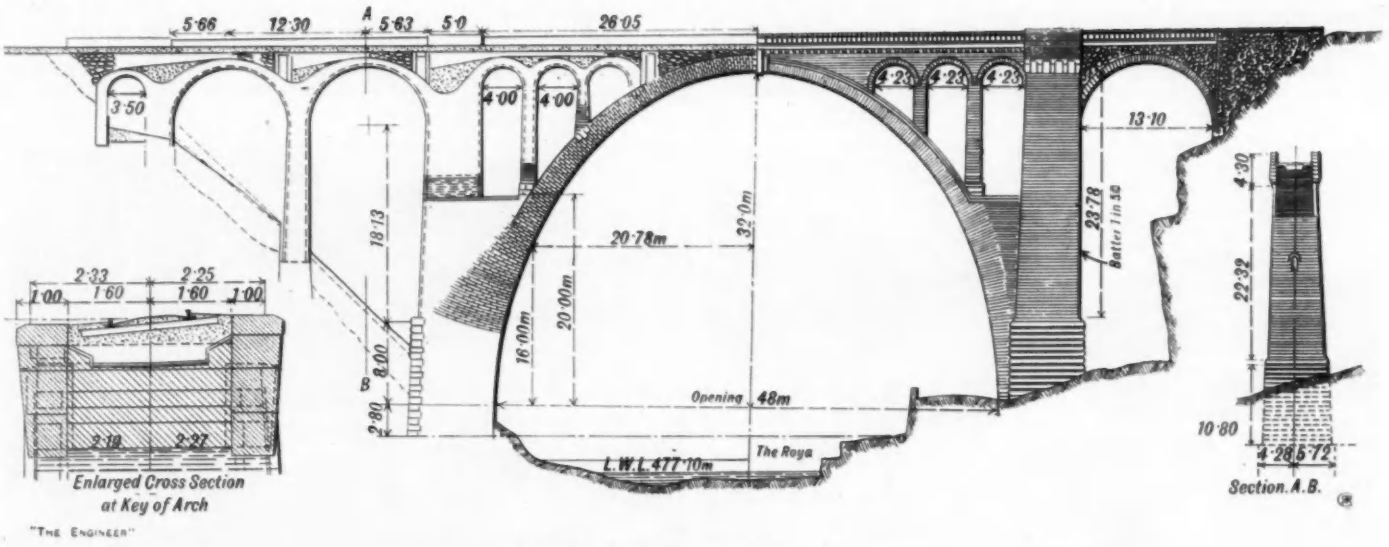


FIG. 8—THE SCARASSOUI BRIDGE

38·94 m. and a total length of 220 m., comprises eleven arches with 15 m. openings.

The viaduct, known as the Viaduc des Eboulis, page 436, is situated on the right bank of the River Roya on

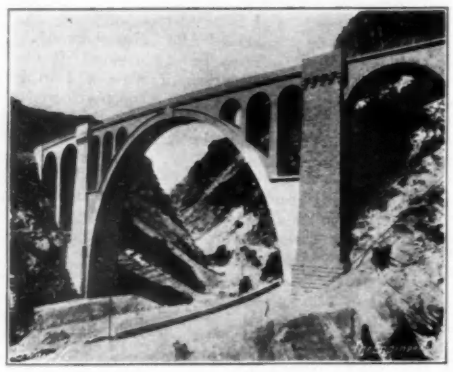


FIG. 9—SCARASSOUI BRIDGE

the Vingetimille branch, at a point where, in time past, there had been an extensive landslip. Its openings have, in consequence, been made specially wide so as to allow of the passage through them of

FIG. 10—SAORGE BRIDGE

soil in case further slipping should take place. It comprises eight arches, each with 18 m. openings, and has at each end a short length of viaduct having 7 m. openings. On the side of the landslip four of the piers of the central portion are furnished at their bases with pointed prows, the object of which is to split up the moving mass of soil, should there be any further slip.

The Scarassoui Bridge, which is illustrated in Figs. 8 and 9, is one of the handsomest works on the line. It crosses the Roya at a height of 42·3 m., and is built on a curve of 300 m.—nearly 15 chains—radius, and on a gradient of 21·3 per 100, or, say, 1 in 47. The main arch, which is elliptical in shape, has an opening of 48 m., and a rise of 32 m. Still another masonry bridge of note is the single-arch structure—the Saorge Bridge—which has an opening of 40 m., and which crosses the Roya at a height of 59·22 m. The haunches of this bridge are founded direct on the rocky sides of the gorge, which are at that point steep and rugged—see Fig. 10.

It is by the courtesy of Monsieur Blot that we are enabled to reproduce herewith, and on page 346, the series of photographs of different portions of this interesting line.

Operation of High-pressure Steam-Electric Generating Stations.

By I. E. MOULTROP, Boston, Mass.*

In a previous paper† the various factors entering into the design and construction of high-pressure steam stations were discussed with particular emphasis upon the Edgar Station of the Edison Electric Illuminating Company, of Boston. It is the purpose of the present paper to give an account of our experience in operating this station, and, so far as possible, to stress that part which relates to high-pressure equipment.

THE ORIGINAL 1200 LB. INSTALLATION.

A few years ago when steam pressures were advancing moderately a new station did not have to be committed to the designed pressure if this later appeared undesirable. It was at that time always possible to drop back to the original pressure, without any material loss of capacity and consequent increased station cost per unit of capacity. When studies indicated that 1200 lb. was the economic pressure for the Edgar Station, it became evident that there could be no retreat with the entire equipment to the normal pressure of the period. For this reason it was decided to superimpose a 1200 lb. pressure plant upon a portion of a plant constructed for a normal pressure of 350 lb. and to use the exhaust of the high-pressure plant after being reheated to partially feed the 350 lb. turbines. This placed the uncertainties of the development upon a minor part of the equipment, a single high-pressure boiler and a small high-pressure turbine. This equipment has been many times described in the technical Press and elsewhere.‡

The normal 350 lb. pressure plant operates at a pressure 50 lb. higher than, and at a temperature 80 deg. Fah. in excess of, the maximum pressure and temperature we had previously used. Aside from these slight increases, this part of the station differs from our previous plants only in the change from single to two-stage bleeding, the employment of complete alternating-current auxiliary drive, and the use of evaporators and de-aerators in our boiler feed system. These relatively simple changes in equipment have caused no anxiety regarding the ease and safety in operating the plant, and have proved to be of decided advantage.

Fig. 1 shows diagrammatically the plan of connecting the original high-pressure equipment to this normal-pressure plant. As will be noted, a by-pass was put around the original high-pressure turbine primarily to keep the high-pressure safety valves from blowing in case the high-pressure turbine tripped out, and to contribute to the supply of steam to the 350 lb. main in case the high-pressure unit was out of service.

In order that these functions should be carried out under emergency conditions, this by-pass valve was made automatic and so connected that it would open with the tripping of the throttle on the high-pressure unit.

It should be observed that, although we were starting out so as to be able to retrace our steps, nevertheless we found it desirable to plan so that if high pressure proved to be practical we could proceed without further consideration of a normal-pressure plant.

For this reason it seemed desirable to install motor drive for all auxiliary equipment in the plant in order to keep the steam piping at a minimum and as simple as possible. This plan was adopted, but since it was possible to use 350 lb. steam pressure because of the features of design previously described, we installed for operation at this pressure one emergency normal-pressure boiler feed pump, one emergency high-pressure boiler feed pump, one emergency house generator, one emergency exciter, starting oil pumps of all turbines, and soot blowers.

PRECAUTIONARY MEASURES.

With this pioneer installation of high pressure it also appeared desirable to take several precautionary measures in order to avoid anticipated difficulties with the consequent outage of equipment and reduction of station capacity. For example, we were not certain that a 1200 lb. safety valve could blow more than once without requiring reseating. Two pilot valves were therefore installed to warn the operators to take steps to keep the main valve from blowing. These pilot valves were each in series with globe valves so that they might easily be disconnected for repair after taking the wear and saving the main valve. These small pilot safety valves, however, were found entirely unnecessary and have been removed.

Another precautionary measure was the installation of a

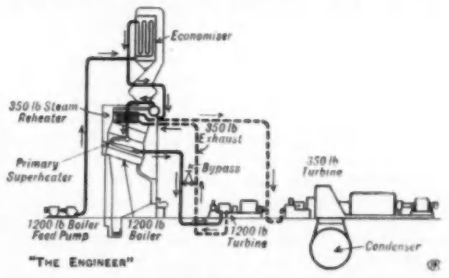


FIG. 1

Diagram showing Steam and Water Flow in the original 1200 lb. installation.

de-superheater in connection with the automatic throttle trip of the high-pressure turbine. This was installed because it was our belief that the steam when throttled through the by-pass valve would reach an excessive temperature when leaving the reheater unless desuperheated. We also found that this, too, was unnecessary because of the combined characteristics of the boiler and reheater. Also, since we did not know the exact temperatures which might be reached at the reheater outlet under all conditions of load for this combination, we installed a by-pass damper, by means of which the outlet steam temperature could be regulated. The design of this damper has been fully described in previous articles. In operation we have never had occasion to use it except as a baffle. It is kept in the maximum temperature position at all times.

We had looked forward to having some trouble in synchronising the high-pressure turbine, therefore a laminated field with a squirrel-cage winding was provided in the generator as first installed, so that the machine could be connected to the system even though not exactly in synchronism. In practice we found that there was no difficulty in synchronising the machine, but since this special field caused undue vibration, the manufacturer changed it to the solid type and thus eliminated this trouble.

EXPERIENCES WITH THE 1200 LB. BOILER.

Although many of the boiler troubles which we looked for and for which we were prepared did not occur, we have nevertheless had real experiences which were not anticipated.

* Chief Engineer, Edison Electric Illuminating Company. Mem. A.S.M.E. Reprinted from *Mechanical Engineering*, April, 1929.

† "High-pressure Steam-electric Generating Stations—Design and Construction," by I. E. Moultrop. Presented at a meeting of the Metropolitan Section of the A.S.M.E., New York, February 4th, 1929.

‡ See "Trans." A.S.M.E., Vol. 50, No. 15, May-August, 1928, p. 32. Presented at a meeting of the Metropolitan Section of the A.S.M.E., New York, February 4th, 1929.

At the time the first high-pressure boiler was installed no feed water regulators had been developed for the pressure used. Although we knew nothing of the water level stability in a high-pressure boiler, we did not anticipate any trouble in maintaining a constant level in the boiler drum. We had poor regulation, it is true, but this was not a function of boiler design, but of the differential pressure across the feed valves, which was several times greater than ever before encountered. Since these valves were hand operated we had both high and low water. The high water caused no damage, although several times it was carried over into the turbine. The low water, however, may have contributed to the trouble which we have experienced with warped tubes. It cannot be definitely stated that the warping of the lower row of tubes was due to low water, but this may reasonably be assumed. Finally, our difficulties in feeding the boiler came to an end with the installation of feed water regulators. These in general have proved satisfactory, but they required several modifications to adapt them to high-pressure service.

We have experienced considerable trouble with

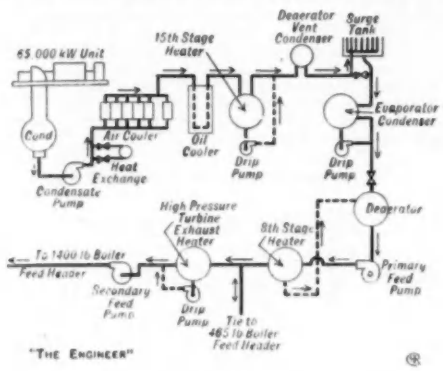


FIG. 2

Condensate and Boiler-Feed—Edgar Station Extension.

economiser tube leakage due to insufficient rolling when installed. Inasmuch as this trouble occurred on low-pressure economisers as well as the first high-pressure economiser, it cannot be attributed to high pressure.

When the plant was started we had indications of corrosion in our economisers. This corrosion was caused, we believe, by dissolved oxygen in the feed system. Fortunately the economisers took the brunt of this attack, and in functioning as chemical deaerators apparently saved the boilers from any corrosion. At the time this corrosion was discovered, to be on the safe side we began to treat our boilers internally while we were correcting the difficulty with our deaerating equipment. We now run zero oxygen in our boiler feed system, and have practically arrested the corrosion. We hope that we shall be able to eliminate corrosion entirely by feeding chemicals through the feed system so as to maintain a slightly alkaline feed rather than a neutral or slightly acid feed as at present.

The drop in pressure between boiler and turbine is greater than expected, and we find that we are not able to get the expected amount of steam through the turbine at this decreased throttle pressure. For this reason we run the high-pressure boiler somewhat under the capacity of its stoker, except when we are short of 350 lb. steam. In this case we crack the by-pass valve around the turbine. This operation, however, results in an increased line drop, with consequent slight reduction of throttle pressure and of high-pressure unit load. We have found that it is impossible to keep the high-pressure boiler on the line over one week when running with the turbine by-pass open on account of slag accumulation on the lower tubes of the boiler. This slag is caused by the high furnace rating. Recently slagging soot blowers have been installed, and we hope that this trouble will be eliminated. Up to the time of writing we have not had an opportunity to give this arrangement a thorough test.

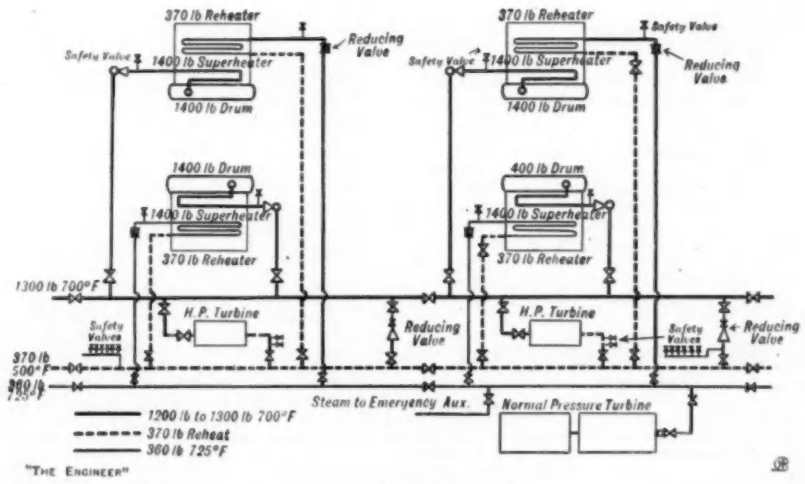


FIG. 3

Steam Piping Arrangement—Edgar Station Extension.

EXPERIENCES WITH THE ORIGINAL 1200 LB. TURBINE.

The first trouble experienced with the original high-pressure turbine was with the shaft packing. Carbon packing rings were placed in series with two sets of labyrinth packing on the high-presaure end and a single set of the same packing on the low-pressure end. The carbon packing seized and went to pieces. It was replaced with the labyrinth type, which has since proved very satisfactory.

An inspection of the high-pressure unit after 1600 hours of service revealed bent buckets in the first two and last two rows. We were unable to account for this, and concluded that it must have been caused by some foreign material. The unit was first put in service December 5th, 1925, and up to December 31st, 1928, had 16,042 hours of service out of a possible 26,928 to its credit, and had generated 31,829,000 kWh. It has been practically a 100 per cent. reliable unit, its outage being caused mainly by the necessity for boiler cleaning, as well as for stoker and furnace repairs.

Early in January, 1929, this machine was opened for inspection. The buckets were corroded and there were considerable deposits in the nozzles as well as on the buckets. Five first-stage buckets were found cracked at the root and were removed, as were an equal number on the opposite side of the wheel to maintain balance. The unit has been closed up and put back in service pending a decision on what is to be done with the rotor.

The loading of this unit is necessarily a function of the boiler output. Our original intention was to run the boiler at variable pressures according to boiler output, allowing the turbine to drift. But the governor was found to control the unit satisfactorily, and it was decided to run the boiler at constant pressure. Our practice is to use high pressure to the fullest extent possible, and we have never had to operate with varying pressure. Had we attempted to operate this boiler and turbine at varying pressure we should have discovered that such a procedure was impracticable for several reasons which will be brought out in connection with later superheater failures.

It is to be observed that the loading of the high-pressure turbine and boiler offered no difficulty. We put the equipment in service and allowed it to run at a fixed load, the system base load always creating a demand for the exhaust steam.

EXPERIENCES WITH THE ORIGINAL 1200 LB. BOILER FEED PUMPS.

The feed pumping equipment in the original 1200 lb. installation consists of two 300 gallons per minute pumps, one running at 3500 revolutions per minute and the other at 4500 revolutions per minute. The 3500 revolutions per minute pump is motor driven and the other pump steam driven. The steam-driven pump has given no trouble and has had very little service. The motor pump has been run approximately the same number of hours as the original high-pressure boiler. The principal difficulty with this pump has been the wearing of its hydraulic thrust plate, which has to be replaced about once in two months. We had some difficulty in packing this pump at first, but it is now satisfactory in this respect. There was also leakage between the pump shaft and the packing sleeve.

RECENT ADDITION TO CAPACITY AT 1200 LB. PRESSURE.

When the time came to put in additional capacity at the station, the question arose of continuing with 1200 lb. pressure at the boilers with reduced pressure at the high-pressure turbine throttles, or to increase the future boiler pressure so as to give 1200 lb. at the throttles as originally intended. In one case we were faced with an obvious loss in economy due to a pressure which was not up to our expectation; in the other, with difficulties in the way of operating boilers in parallel and the emergency use of pumps. The final decision in the matter was to take the step at this time to 1400 lb. boiler pressure for the new boilers, giving 1200 lb. at the throttle. While this adds complexity to the station as its stands to-day, the ultimate result will be more satisfactory from all points of view.

The pressure having been settled, we proceeded to install two 1400 lb. boilers and one 10,000 kW high-pressure unit as described in the previous paper.†

OPERATING FLEXIBILITY.

Figs. 2 and 3 are respectively water and steam flow diagrams for the recent 1200 lb. addition to the station. It is evident from a study of these diagrams that, irrespective of the fact that we have three different boiler pressures, we have a high degree of flexibility in the operation of the plant. Steam from any boiler can be used in any low-pressure turbine, but the distribution of boiler-room load between high and low-pressure boilers is at present under hand control and is now accomplished by the regulation of load on the high-pressure turbines, the low-pressure boilers taking the variations on the automatic boiler control.

In order to make the plant flexible so that any boiler can supply steam to any low-pressure turbine, it becomes necessary to have a common tie at some point in the condensate return. This is accomplished by means of a 500 lb. tie line between the feed pumps for the high-pressure and low-pressure plants. The reason the tie has been continued at this point is because the surge tanks are at different levels. Having no other common point at which to tie them has also forced us to continue to split our pumping pressures at 500 lb. The transfer of condensate is accomplished by varying the speed of the 500 lb. pumps as indicated by the surge tank levels. Between the two surge tanks also are other transfer arrangements which function automatically at high or low levels. In practice we have had no difficulty in maintaining either proper steam or water distribution in the plant.

EXPERIENCES WITH 1400 LB. BOILERS.

The first high-pressure boiler in our recent addition went into service in September, 1927. Since that time we have had a varied series of experiences, not all due to high pressure, but largely to other features of new development.

During the early stages of operation we ruptured several superheater tubes on both of the new high-pressure boilers. Two of these failures were caused by faulty steam distribution in the superheater. Further failures have been prevented by changing the distribution baffles in the superheater headers, and by installing ferrules in the first pass of the superheater. Apparently this source of trouble is now behind us.

During the time when ruptures were occurring in the superheater, it developed that there was a hazard in running the boiler pressures considerably below the popping pressure of the superheater safety valves. Under these conditions, in case of sudden loss of load on the station, the superheater valve would not blow and thus allow steam to cool the superheater until sufficient steam had been generated to raise the pressure in the boiler to the popping point of the safety valves. The interval of time required for this was sufficient for the superheaters to become overheated. It also developed that in calculations for high-pressure boilers, allowance should be made for the higher volume of low-pressure steam so as to permit operation at low pressure.

About the time when the superheater tubes were bursting a rear water wall tube ruptured just above the ashpit. This failure was attributed by the manufacturers to faulty circulation due to inadequate capacity in water feeders, re-circulators, and steam vents from the upper wall header to the boiler drum. The number of feeders and of re-circulation and steam vent pipes was increased, and we looked for the end of this trouble. Recently, however, after the changes had been made, a smilar rupture occurred in the rear wall of the other boiler. This failure showed the larger opening which occurs when the tubes are covered with cast iron waffle blocks than when covered with steel blocks.

The theory has been advanced that possibly this last water wall failure may be attributed to blow-torch action on the wall. In order to prevent a recurrence of this trouble, refractory faced blocks were installed in place of the cast iron waffle blocks near the clinker pit on the rear wall. While this measure may be effective, it is our opinion also that variations in water level in the boiler drum change the hydraulic head sufficiently on the wall feeders to unbalance the circulation and cause trouble. This opinion was strengthened when later a feed water regulator stuck, allowing the water level to drop to approximately 2in. above the bottom of the gauge glass, when leaking was noted in a wall feeder at the point where it is rolled into the drum. In opposition to this theory, however, it has been suggested that the leakage was caused by a sudden increase of boiler feed at this time. Whatever might have been the cause, it is evident that the condition must be remedied.

Bringing a cold boiler into service has been a frequent cause for leaks of this nature in water wall supply tubes where they are rolled into the drum. The theory advanced is that when starting up and bringing the boiler up to pressure, the boiler tubes absorb heat more rapidly than the water walls. This hot water is not drawn from the drum into the water walls, as circulation in the latter has not yet started. Consequently there is a difference of temperature of approximately 200 deg. Fah. between the water wall feeders and the boiler drum, causing expansion and leakage at the point of rolling the tube into the boiler drum. This theory is borne out by the fact that artificial circulation set up by bleeding a small quantity of water from the bottom of the wall, while starting up, has caused this trouble to disappear.

Recently it was discovered that several of the 2in. boiler tubes in the upper bank of the last two boilers had been overheated. On one of the boilers, one tube was bagged and leaked, and several others showed signs of distress. Investigation disclosed an exceptional concentration of flame close to the uptake headers and extending to the top of the first pass, largely due to the heavy accumulation of slag in the bottom of the boiler. This produced an unusual localisation of heat on the bottom tubes of the upper deck. The condition was investigated by the manufacturer and corrected by diverting water from the lower to the upper bank.

EXPERIENCES WITH THE NEW 1200 LB. TURBINE.

The new 10,000 kW high-pressure turbine also has given us many new experiences. When this turbine was put in service it leaked badly at the horizontal joint in the casing. It was sent to the factory, where a large amount of metal was cut off the flanges to render them more flexible and to permit the use of shorter bolts. When it was opened up after a very few hours' service to have the flanges fixed, it was found that one bucket was gone from the last stage. The last four stages were re-bucketed with heavier buckets.

After these changes this turbine was again put in operation and has since operated satisfactorily. In the year 1928 this machine ran 3300 hours out of the possible 8784 hours, generating a total of 15,684,000 kWh. The exhaust steam from the unit generated approximately 60,000,000 kWh in the 350 lb. machines. The low figures for running hours and kilowatt-hours for the high-pressure unit are primarily due to the development and repair work on the new boilers and stokers. The turbine was approximately 100 per cent. available.

This high-pressure unit is equipped, as will be our third 1200 lb. unit, with a pressure governor which admits

steam to the unit in sufficient quantity to maintain approximately 360 lb. pressure in the turbine exhaust. The load on the high-pressure turbine, therefore, is governed by the pressure in the low-pressure main, which latter is held constant also by the Bailey control for the low-pressure boilers. In the original design it was intended that the Bailey control on the low-pressure boilers should come into play after the high-pressure turbines were wide open. However, as the high-pressure part of our plant is not yet completely developed, we are setting the speed governor on this unit for the load which the high-pressure boilers can carry, allowing the low-pressure boilers to take the swings and maintain pressure. The pressure governor on the present high-pressure unit is set at a pressure above that of the low-pressure main, and will function, in case of a sudden decrease in load on the normal-pressure part of the station, to shut off steam going through the high-pressure unit and prevent the reheater safety valves from blowing. The Bailey control on the fans of the high-pressure boilers maintains constant pressure on the high-pressure steam main, and under the above conditions would tend to keep the high-pressure boilers from blowing. The by-pass valve for this turbine is opened automatically either by the pressure governor when the 350 lb. main pressure falls or when the turbine trips out.

Experiences with 1400 lb. Boiler Feed Pumps.

As our experiences have been more varied with the second high-pressure boiler and turbine installation than with the first, so also have been our pump experiences, and since the new installation is of a different pressure than the old, we have not had the pumps of the original installation to fall back upon.

The pumps installed with the new 1400 lb. boilers consist of two units in duplicate, connected in series as shown diagrammatically in Fig. 4. The first is a 500 lb. unit

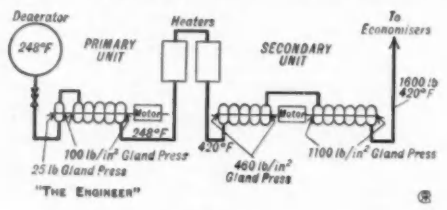


Fig. 4

Simplified Boiler-Feed-Pump System—Edgar Station Extension

taking hot water from the deaerator under low head. The water is first passed through a one-stage booster pump mounted on the shaft of the large pump. The large pump is a volute pump of five stages. The only trouble we have experienced with this unit has been hydraulic thrust wear. This 500 lb. unit discharges water through heaters to a secondary pumping unit consisting of a volute pump similar to the five-stage pump and a six-stage turbine pump. These two pumps comprising the secondary unit are mounted on opposite ends of a slip-ring motor shaft.

We have experienced considerable trouble with these secondary pumps. The thrust plates have worn very rapidly, but we have been able thus far to run one pump long enough to allow us to repair the other and hold it in reserve for approximately two weeks before it is necessary to repeat the operation. In this manner we have been able to keep the plant in operation during our winter load. One of these pumps recently broke its shaft and caused considerable damage.

Shaft packing has also been a troublesome problem. Various kinds of metallic and other packings have been tried. Metallic packings which on lower pressure installations have given satisfactory service have under our high-pressure conditions given only fair service. We have a high-pressure extraction heater which takes steam from the exhaust of the high-pressure turbine. This heater in normal operation delivers water at approximately 420 deg. Fah. to the suction of the secondary pumping unit. This hot water accentuated our packing troubles, so we temporarily discontinued the use of the heater.

These pumps have been recently rebuilt by the manufacturer with larger shafts, Kingsbury thrust bearings, and labyrinth shaft packings. At the time of writing the high-pressure heater is in service and the pumps are operating very satisfactorily.

In addition to these pumps we have a six-stage 3600 revolutions per minute turbine-driven pump designed to deliver 900,000 lb. of water per hour at 1600 lb. per square inch. This pump was originally intended to take water either from the yard storage reservoir at about 4 lb. pressure at 60 deg. Fah., or from the deaerator under approximately 25 lb. at 250 deg. Fah., or by means of by-passing the deaerator from the surge tank at 50 lb. pressure and 150 deg. Fah. No booster is used with this pump, and, although its operation is satisfactory when connected to either the yard storage reservoir or surge tank, it fails to operate when taking water from the deaerator. To correct this, several first-stage impellers were tried by the manufacturer without success. A great deal of trouble was encountered due to vibration, and the bushings in the pump seized on several occasions. This pump is largely for emergency use, and as such in taking water from the yard reservoir its operation would be considered satisfactory. However, since its cost is high, we should like to have it available as a spare for short periods while the other pumps are being overhauled. Under these conditions, cold undeaerated water from the yard reservoir or the surge tank would not be favourable to economy or safety. Therefore it is highly desirable that the pump should work satisfactorily under the normal operating conditions of the other pumps. The manufacturer feels that a first-stage impeller can be designed to function properly under these severe conditions, and is now carrying on development work for this purpose. While this is in progress we stand by with the pump connected to the reservoir ready for emergency service only.

During all of our pump trouble it was decided to reset the safety valves on the two 1400 lb. boilers to blow at the same pressure as the original high-pressure boiler, so that in case we lost all of our new high-pressure pumps we could feed across with the original high-pressure pumps and thus have additional insurance against burning our boilers. As a result of this arrangement we have a very high differential pressure across our boiler feed valves, and consequently have been compelled to regulate the boiler feed by hand. As soon as our boiler pumps are operating satisfactorily, we shall return the 1400 lb. safety valves to their original settings, use the feed water regulators, and thus eliminate the danger from hand control.

Furthermore, it is difficult to obtain satisfactory boiler feed pressure regulation with electrically driven feed pumps employing slip-ring motors. This is due to the fact that the head capacity curve of a slip-ring motor-driven pumping unit is very steep on account of the well-known speed-torque relation of the motor. This inability to slow down slip-ring motors is observed also to a slight extent with normal-pressure equipment. In high-pressure pumps, however, it is particularly noticeable.

Station Economy—Pounds of Coal per Kilowatt-hour.

The prime reason for advancing to higher pressures is because of the gain in economy. Fig. 5 shows the relation

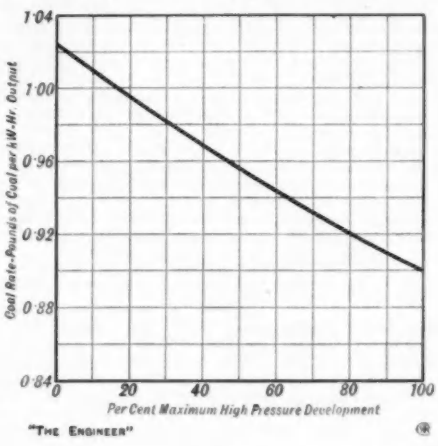


Fig. 5

Relation between Coal burned per kWh. and percentage of maximum possible high pressure generation.

between the coal consumed per kilowatt-hour generated and the percentage of maximum possible high-pressure generation. It will be noted that the coal consumption of the 350 lb. part of the station under the prevailing conditions represented by the chart is about 1·02 lb. per kWh, and that there is a gain of 12 per cent. with the use of high-pressure equipment to the full extent or when the normal-pressure units are supplied entirely by high-pressure unit exhaust. The coal burned is New River semi-bituminous and has a calorific value of 14,050 B.Th.U. per pound as fired. Our equipment at Edgar Station is a partial development, so that the fuel consumption of the station should fall only part way down the curve.

After making allowances for the lack of availability of boilers due to boiler, stoker, and pump developments and to other unavoidable operating factors, the fuel consumption figures fall surprisingly close to the line and confirm the expectation which has been entertained with regard to the high-pressure gain.

Conclusions.

A close study of the troubles experienced always gives an unfavourable impression of any installation. In general, however, all new departures are certain to be attended by small difficulties which require correction, but in this respect high-pressure steam has not developed any difficulty that was not readily taken care of. It is therefore our conclusion that high-pressure steam for electric power generation is entirely practical and with regard to efficiencies is meeting, and will continue to meet, the expectations of the designers.

The Quarter's Shipbuilding Returns.

From the statistics issued by Lloyd's Register of Shipping regarding vessels under construction at the end of March, we gather that in Great Britain and Ireland there was an increase of 114,581 tons in the work in hand, as compared with the figures for last December, although the present total—1,357,375 tons—is still 83,467 tons lower than the tonnage which was being built at the end of March, 1928. From a diagram issued with these returns—which shows the tonnage being built in this country at the end of each quarter since 1882—it is seen that the average tonnage under construction during the last six completed years—1923–1928 inclusive—only amounted to about 1,220,000 tons, as compared with an average of over 2,000,000 tons for 1913, the record pre-war year. It may be of interest to state that about 200,000 tons of the tonnage now in hand in this country are intended for the British Dominions, and about 188,000 tons are for sale or for foreign shipowners.

The tonnage now under construction abroad—1,480,437 tons—is 105,230 tons higher than the work which was in hand at the end of December. Five countries abroad have more than 100,000 tons under construction, viz.:—Germany, 406,982 tons; Holland, 163,856 tons; France, 155,351 tons; Japan, 147,010 tons; and Russia, 116,388 tons. The total tonnage under construction in the world amounts to 2,837,812 tons, of which 47·8 per cent. is being built in Great Britain and Ireland, and 52·2 per cent. abroad; while the average percentages in the last twelve months before the war were 57·2 for Great Britain and Ireland and 42·8 for abroad. In Great Britain and Ireland 362,358 tons were commenced—a decrease of about 69,000 tons over the similar figures for the December quarter—and 289,834 tons were launched. Similar figures for abroad are 298,281 tons commenced, and 214,600 tons launched.

A reduction is again shown in the tanker tonnage under construction, the present figures being forty-seven vessels of 331,411 tons, of which 148,480 tons are being built in Great Britain and Ireland and 53,951 tons in France.

While in Great Britain and Ireland the tonnage of motor ships under construction—537,289 tons—is much less than the tonnage of steamers being built, the motor ship tonnage being constructed abroad reaches 862,292 tons, as compared with 610,346 tons of steamers. The continued progress in the employment of the internal combustion engine for the larger vessels is indicated by the fact that, while there are now being built in the world sixty-one motor ships, each of 8000 tons and upwards, only thirty-three steamers of such size are under construction.

The table respecting marine engines does not show complete world figures for marine engines of all types, as the figures for steam turbine engines being built in Germany are not available; but the table shows that the indicated horse-power of reciprocating steam engines now being built or fitted on board amounts to 573,508 horse-power, while the figures for oil engines aggregate 1,239,000 horse-power.

The tonnage being constructed throughout the world under the inspection of Lloyd's Register reaches 1,685,158 tons, of which 1,078,527 tons are being built in Great Britain and Ireland.

THE NEWCOMEN SOCIETY.

The Summer Meeting of the Newcomen Society this year is to be held at Dartmouth, Devon, in conjunction with the Devonshire Association, to commemorate the bicentenary of the death of Thomas Newcomen. The provisional programme is as follows:—On Tuesday, July 23rd, at 10 a.m., the Devonshire Association meetings will begin. In the afternoon at 4.30 p.m. there will be a joint reception by the Mayor and Town Council of Dartmouth; procession to Newcomen Monument in Town Gardens, when chaplets will be deposited and orations made. In the evening at 8 p.m. the President of Devonshire Association will deliver an address. The morning of the Wednesday will be devoted to the reading and discussion of papers, while in the afternoon there will be a joint short excursion to Dittisham and/or Greenway. In the evening at 8 o'clock a popular lecture will be delivered by Engineer-Captain E. C. Smith, late R.N., on "Newcomen and Two Centuries of Steam Engineering."

On the Thursday there will be an excursion, possibly to Saltash Bridge, to examine the alterations, or, alternatively, visits will be paid to motor-boat building yards in Dartmouth. In the evening there will be a joint entertainment, offered by the Town Council. On the Friday there is to be a joint whole-day excursion to Totnes, Ashburton—iron smelting works—Venford Reservoir, Hexworthy, and Swincombe tin mine.

It is hoped to hold during the week a small exhibition of Newcomeniana at the Town Hall.

The Diesel Electrically-propelled Oil Tanker "Brunswick."—A recent inspection of the electrically-propelled oil tanker "Brunswick," belonging to the Altantic Refinery Company, Ltd., which has now completed more than 48,000 miles on her seven months of service shows, the British Thomson-Houston Company, Ltd., informs us, that the electrical plant is in as good a condition as when it was installed. The inspection of the machinery was carried out at Thameshaven after a recent voyage from California to Australia. A full description of the "Brunswick," which was built by Scotts Shipbuilding and Engineering Company, Ltd., of Greenock, will be found in the issues of The Engineer for September 7th and 14th, 1928.

Faraday House Entrance Scholarships.—As a result of the entrance scholarship examination held at Faraday House Electrical Engineering College, on April 9th, 10th and 11th, the following awards have been made by the Governors of the College:—J. Rosenkrantz, Central Foundation School, London, the "Faraday" Scholarship of fifty guineas per annum, tenable for two years in College and one year in works; H. T. Horsfield, Erith County School, the "Maxwell" Scholarship of fifty guineas per annum, tenable for one year in college and one year in works; J. Ruston, Borden Grammar School, Sittingbourne, an Exhibition of forty guineas per annum, tenable for one year in college and one year in works; J. Salomovitch, Central Foundation School, London, and Exhibition of forty guineas per annum, tenable for one year in college and one year in works; P. G. Chick, King Edward VI. School, Norwich, an Exhibition of thirty guineas per annum, tenable for one year in college and one year in works; A. M. Midgley, University College School, an Exhibition of thirty guineas per annum, tenable for one year in college and one year in works; H. R. Rowbotham, Aldenham School, Herts., entrance prize of twenty guineas; R. W. Partridge, Repton School, entrance prize of twenty guineas; and G. S. Pillans, Brighton College, entrance prize of ten guineas.

Liege International Exhibition, 1930.—Liége has decided with the approval of the Belgian Government, and under the patronage of the King of the Belgians, to celebrate the Centenary of National Independence by an International Exhibition of Industry, the Sciences and their Applications. One section of the Exhibition will be devoted to concrete and to reinforced concrete. The very active development of the technique of these materials gives to the organisers of the Exhibition ground for hoping that this section will be the object of universal interest, and the Executive Committee has considered the moment favourable for inviting specialists from all countries to meet at Liége for an International Congress on Concrete and Reinforced Concrete. It is hoped that foreign participation will be considerable, and an appeal is addressed to the specialists of the whole world to take part in the Congress. The terms of reference of the Congress are not yet fixed, but, as it is the first of its kind, and as no tradition or permanent organisation exists, the Organising Committee is of opinion that the programme should not be strictly limited, but that it should be left to foreign delegations to present such communications from their countries as offer real interest for the Congress. The Congress will probably take place during the months of July, August and September, 1930. All communications and correspondence respecting it should be addressed to the secretary, the First International Congress for Concrete and Reinforced Concrete, 4, Place St. Lambert, Liége, Belgium.

Railway and Road Matters.

THE Benguella Railway, from Lobito Bay, on the West Coast of Africa, to the Congo, is to be opened early in June.

THERE is a proposal in Canada for the construction of a new railway from Winnipeg to Fort Churchil, on Hudson Bay, by a route to the east of Lake Winnipeg. It would be 700 miles long, and the necessary capital is said to be forthcoming.

THE highest point in the membership of the National Union of Railwaymen was in 1919, when it stood at 481,000; at the end of 1925 it was 398,600; but now is down to 308,046. The decrease is alleged to be due mainly to "the large number of retirements from the service of men over the age of sixty-five years." We may mention that in 1913 the number of railway servants was 639,323; in 1921—during Government control and after the introduction of the eight-hours day—it was 763,259. To-day it is 683,077.

UNDER Sec. 59 of the Railways Act, 1921, the Railway Rates Tribunal is authorised to review the standard and exceptional charges of the companies in the light of the year's results, and to make such modifications as they may think necessary to enable the company to earn the standard revenue fixed by the Tribunal. That body will now meet on Monday, May 6th, for that purpose, but it is safe to say that, although the net revenue for 1928 was about nine millions less than the standard revenue, there will be no increase in passenger and goods charges, except, perhaps, in a few exceptional rates.

IN this column of our issue of March 22nd we referred to the *Railway Newsletter*, which is an official publication of the British Railways' Press Bureau, and supplied free to the Press, as the United States Railways' *Railway Data* is in America. A short interesting article in the April issue is "Famous Night Flyers: Trains that Never Sleep." It refers, of course, to the night trains to the North and Holyhead, the continental boat trains, &c., and mentions the "nameless squad" which brings fish, meat, dairy produce, milk, &c., to London and other large cities. An American edition is now published.

WHILST the Southwold Railway was in the area of the London and North-Eastern Railway, it was not absorbed by that company under the Railways Act, 1921, but was deliberately excluded therefrom, owing mainly to the fact that it was of 3ft. gauge. The transfer of goods and coal traffic was therefore costly, and its conversion to standard gauge would not justify the expense; moreover, the speed limit laid down by the Board of Trade was 16 miles per hour. Road motor services have now killed both the passenger and goods traffic, and the line, when within five months of its jubilee, was closed down on April 11th.

THE Order obtained from the Railway and Canal Commission by the Tilmanstone Collieries to make a ropeway to the port of Dover, referred to in this column on February 1st last, was mentioned in the annual report, for 1928, of the Commission as a decision of great importance, and one that had been affirmed by the Court of Appeal. The report observes that:—"This interpretation of the Act of Parliament means that very large powers are given to the Railway and Canal Commission to over-ride the rights of property owners: but the powers are granted to Commissioners presided over by a Judge of the High Court of Justice, the applications for facilities are heard in public, and the Commissioners have power to impose reasonable conditions and to award compensation."

THE resignation is announced of Mr. J. R. Bazin, the chief mechanical engineer of the Great Southern Railways of Ireland. Mr. Bazin was connected with the Great Northern—of England—Railway from 1897 to 1919, when he went to be works manager at Inchicore, Great Southern and Western, and succeeded Mr. E. A. Watson as chief mechanical engineer in November, 1921. On the constitution of the Great Southern Railways in 1924 he held that office for the combined company. Mr. Bazin is being succeeded by the deputy chief mechanical engineer, Mr. W. H. Morton, who went from Kitson and Co., in 1900, to the Midland Great Western, where eventually he became in 1915 the chief mechanical engineer, and on the amalgamations was made Mr. Bazin's deputy.

WHAT are known in this country as movable crossings have been introduced on to the South African railways. They allow for crossings to be laid in at a flatter angle than is possible with fixed crossings. They are particularly useful for crossover junctions where there are four lines of running road, as trains may run from the fast to the slow lines and *vice versâ* at speeds of 45 to 50 miles per hour instead of the usual 20 to 25 miles per hour. The movable crossings now introduced into South Africa for the first time are not, however, used as above, but to give better connections into and out of the carriage sidings at Salt River Junction. The report of the South African Government Railways for the year ended March 31st, 1928, says that although the design entails additional signalling work, it is an improved arrangement over the old double slip and provides increased safeguards in the running of passenger trains.

ACCORDING to the Board of Trade returns, the value of the railway material exported during the first two months of the present year was as follows, the corresponding figures for 1928 and 1927 being added in brackets:—Locomotives, £464,292 (£409,859, £142,309); rails, £622,034 (£702,487, £188,879); carriages, £355,689 (£801,284, £382,908); wagons, £535,896 (£693,847, £324,491); wheels and axles, £74,209 (£204,976, £58,055); tires and axles, £95,741 (£113,740, £51,523); chairs and metal sleepers, £90,147 (£151,479, £40,839); miscellaneous permanent way, £193,879 (£188,471, £182,043); total permanent way, £1,076,010 (£1,361,123, £521,339). The weight of the rails exported was 72,277 tons (79,550 tons, 16,034 tons), and of the chairs and metal sleepers, 9230 tons (15,097 tons, 4666 tons). During the month of February last there were locomotives to the value of £139,413 sent overseas, which included:—India, £65,624; South Africa, £29,739; the Argentine, £9560; Straits Settlements, £6570. The total value of the rails shipped during February was £316,394, and included:—The Argentine, £137,414; South Africa, £76,336; New Zealand, £13,954; Straits Settlements, £8547; India, £5226.

Notes and Memoranda.

INVESTIGATIONS carried out by the United States Bureau of Mines show that the prevention of the extension of explosions in coal mines by means of dusting requires the provision of 75 lb. of dust for each square foot of the cross-sectional area of the entry.

THE export shipments of high-grade Swedish iron ore reported by the Graengesberg Company for the month of March amounted to 449,000 tons, against 438,000 tons in February and 345,000 tons in the month of March last year. During the first three months of this year the total shipments amounted to 1,411,000 tons, against 1,169,000 tons during the corresponding period 1928.

IN a lecture recently delivered before the Royal Meteorological Society, Mr. R. A. Watson Watt pointed out, in connection with the popular fallacy that wireless transmission affects the weather, that the average rainfall in England requires, for its evaporation, the expenditure of energy at the rate of a third of a million horse-power per square mile, night and day, throughout the year. On the other hand, the total power emitted by the broadcasting stations of the British Isles amounts to only 55 horse-power.

A MESSAGE from Stockholm states that the United Carbonic Acid Works has begun to produce carbonic acid "ice" on a large scale in its Liljeholmen works near that city. The "ice" is formed by the method employed there at the rate of 1 kilo. per minute. When packed in an insulated wrapper the material melts at a quite slow rate. It is stated that one unit of the "ice" will take the place of ten units of ordinary ice mixed with salt. The product is, in the first place, intended for the transport of fresh foodstuffs.

A NOTABLE piece of work was accomplished when one of the 17,500 kVA hydro-electric generating sets of the San Francisquito power plant, near Los Angeles, was put in service three months after it had been wrecked by the flood caused by the failure of the St. Francis Dam. The failure of the dam was described in THE ENGINEER of May 25th and April 6th, 1928, and resulted in a flood which overtopped the power plant by 125ft. The power-house was completely demolished, but the heavier parts of the two units remained in place. A description of the rehabilitation of the plant is given in the *Engineering News-Record* of March 28th.

IN connection with the future prospects of low-temperature carbonisation, *Fuel and Combustion Records* says: With the possibility of further taxation following on the recent rise in petrol prices, we may look for a further crop of hope expressed in regard to the home production of coal oil. When the last Budget imposed 4d. a gallon duty on imported petrol, it was popularly hailed as an important stimulus to low-temperature carbonisation, though most writers ignored the fact that the imposition was equivalent to something less than 1s. a ton reduction in the price of the coal carbonised for oil production. Doubtless the tax had a definite effect on stimulating public investment in low-temperature carbonisation enterprises; but it will take more than a 4d. tax to bring coal oil production to a sound economic position.

ACCORDING to a communication by Messrs. A. Michel and P. Benazet, in a recent issue of the *Revue de Metallurgie*, quenching a steel with 19 per cent. Cr, 0·8 per cent. Ni, and 0·54 per cent. C from 1250 deg. in oil preserves its austenitic structure. Subsequent annealing at various temperatures in the Chevenard dilatometer results in negative anomalies in the expansion curve at 150 deg., 260 deg. and 600 deg. The last-named is attributed to precipitation of carbide from the super-saturated austenite phase, and the others to changes in the alpha phase produced on annealing. This behaviour is compared with that of a steel containing 6 per cent. Cr, 6 per cent. W, and 25 per cent. CO, which recalesced vividly on annealing it in the austenitic state at 700 deg., and it is concluded that a high chromium content retards this recalescence and tends to retain a martensitic instead of a pearlitic structure.

AFTER tests of a catapult pick-up device recently, Lieutenant H. B. Clarke, manager of the Roosevelt Flying Field, announced that in about a month he would attempt to better the refuelling endurance flight record of the army plane "Question Mark." The machine which he proposes to use for the purpose is a circular device that can be wheeled about to any position and set up in a few minutes. A dangling rope from the plane releases the catapult just as the article to be picked up is automatically fastened to the rope, which throws the article towards the plane as the rope is reeled in and prevents shock. In six tests made by Lieutenant Clarke a short time ago packages ranging up to 40 lb. were picked up. The lightest package contained a dozen eggs, none of which was broken. Lieutenant Clarke proposes to use a multimotored plane for the endurance flight, picking up fuel in 250 lb. lots. He expects to have an alternative pilot and a mechanic on board, and is considering changes of pilots during the flight.

PREPARATIONS are being made for the building of a large collection of factories to use current generated by the big Dnieprstroi power station. A site of 12½ square kilometres to the north of the town of Zaporozhyé on the bank of the upper basin of the Dneprostroi dam and near the main railway line, has already been chosen. The ground will provide good foundations for the buildings. Transport, water, warehouse and other systems are planned for the joint use of all the factories. This undertaking will be the first concentration of works of such a complicated type in the Soviet Union. Every individual factory is to help one or more of the others. Gases, for instance, will be used for heating all the factories, slack from the ironworks will be used for the manufacture of cement and so on. Planning work is now to be pushed on so that construction work can begin at the end of the year. The first stage in the latter will be the erection of works for the manufacture of building materials. Foreign consulting and technical assistance has been obtained for the group of factories, among the latter being a large establishment for the manufacture of aluminium, skilled workers for which are to be trained at a small factory to be built at Leningrad.

Miscellanea.

THE two blast-furnaces at Jarrow will probably be re-started in about a fortnight's time.

THE average rate charged for electricity by the Clyde Valley Electrical Power Company is 0·749d.

THE lift span of the new railway bridge over Newark Bay, New Jersey, fell from its supports during a wind storm on April 1st.

THE mill of Hamilton Cottons, Ltd., Ontario, is to be extended by the addition of a new yarn mill, at a cost of some 500,000 dollars.

THE Bell Telephone Company of Canada proposes to expend 126,239,000 dollars within the next five years on extensions of its system.

DURING a recent twelve-hour shift as much as 6004 tons of coal were wound from the Frickley Pit of the Carlton Main Colliery Company.

A NITROGEN fixation plant with a capacity of 15,000 tons a year is being put up at Waldenburg, Silesia. Its output is to be doubled subsequently.

THE two new destroyers built by J. I. Thornycroft and Co. at Southampton for the Chilean Navy have arrived at Portsmouth prior to sailing for South America.

A CONSULATE will soon be opened at Liverpool by the Chinese Ministry of Foreign Affairs for the development of trade and shipping relations between Britain and China.

A SYNTHETIC ammonia plant of the Haber type has been ordered from Germany for installation in the French State works at Toulouse. The present output of the Casale unit there is 30 tons a day.

THE plant for the recovery of sulpho-cyanide at the Nechells works of the Birmingham Corporation has been completed, and that at the Saltley works is expected to be in operation very shortly.

WORK has been started on the construction of a road across the mud flats at Dartmouth for the better connection of Plymouth and Torquay. Inshore land is to be reclaimed for pleasure grounds.

THE Chinese Government has appointed a Harbour Preparation Committee, which is to "promote harbour construction in suitable localities along the coast so as to facilitate transportation by sea."

IT is reported that one of the largest smelting plants on the American Continent is to be put up in connection with the Beauharnois scheme for the development of hydro-electric power on the river St. Lawrence.

A BATTERY of coke-ovens, the first on the Becker system in this country, has been put up by the Nunnery Colliery Company, Sheffield, at its Handsworth works, with the object of dealing with coking slack to the best advantage.

SCIENTISTS have specially visited the Grootfontain district, in South-West Africa recently to examine the huge meteorite which has fallen there. Its weight is estimated at 50 tons, and it consists of iron with a proportion of nickel.

IT is proposed to erect a by-product plant at Pencoed in connection with Werntarw Colliery, owned by the Meiros Collieries, Ltd. Similar developments are expected at Kenfig Hill, where a site has been marked out for a distillation plant at Aberbaiden Colliery, owned by Baldwins, Ltd.

THE low-temperature carbonisation plant at Askern Colliery, Yorkshire, which will be capable of dealing with 1500 tons of coal a week, is to be started next month. It is expected that this coal will produce 1050 tons of "Coalite," 30,000 gallons of heavy oil, 3000 gallons of spirit, and 6½ million cubic feet of gas.

THE Soviet Government has now, says *Nature*, completed the first part of an extensive electrification scheme which was begun almost immediately after the Revolution. A large 80,000 H.P. hydro-electric station has been built on the river Bolkhov, about 80 miles east of Leningrad. The power is supplied to Leningrad by overhead lines at 120 kilovolts.

A PARTY which, it is hoped, will penetrate as far north as has ever been done, is now making its way up the coast of Hudson Bay. It includes two 10-ton tractors with a load of 50 tons of supplies for the prospectors who are exploring the mineral possibilities of the "Barren Lands" of Northern Canada. The objective is Mistake Bay, 300 miles north of Fort Churchill.

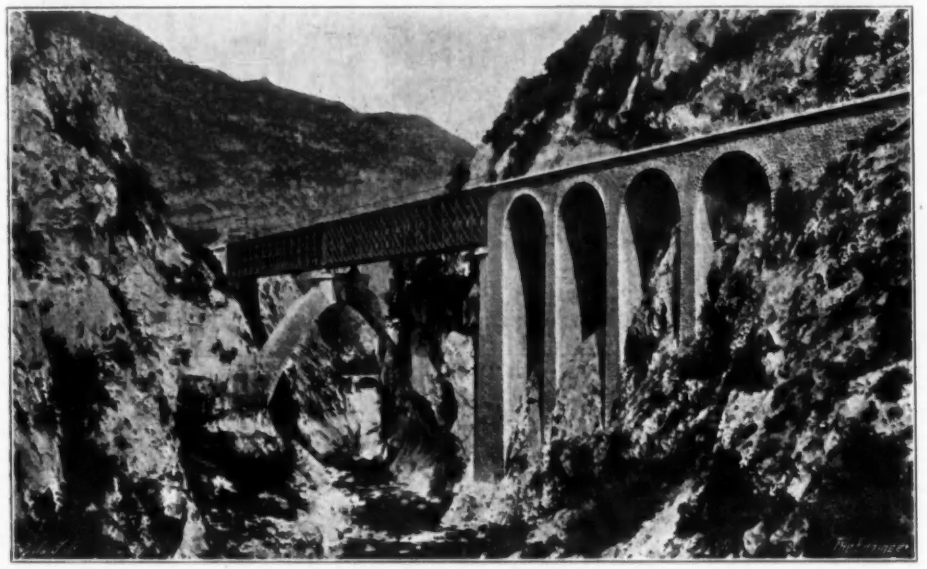
THE harbours at Fort William and Port Arthur, Canada, are to be improved at a cost of 550,000 dollars. The improvements contemplated are the widening of the Kaministiquia River near the plant of the Canada Iron-foundry, from its present width of 300ft. to 500ft., and the completion of the 2000ft. of breakwater at the north end of the Port Arthur harbour, which is now under construction.

WE are informed that Engineer-Commander Geoffrey Morgan, R.N., has been lent to the Egyptian Government for three years, for duty with the fleet and workshops of the Marine Service in the Sudan. He will, in effect, supervise the Egyptian dockyard at Khartoum, and the tugs, dredgers, and craft generally on the Upper Nile. Somewhat similar posts have been held in the past by other engineer officers of the Royal Navy, including Engineer-Commander G. E. Bond, under Lord Kitchener, and Engineer-Commander W. Scott Hill, now a retired engineer rear-admiral.

IT is reported by the National Federation of Iron and Steel Manufacturers that the number of furnaces in blast at the end of March was 145, a net increase of five since the beginning of the month, seven furnaces having been blown in and two having ceased operations. The production of pig iron in March amounted to 590,500 tons, compared with 519,600 tons in February, and 592,600 tons in March, 1928. The daily rate in March was thus 19,048 tons, compared with 18,557 tons in February. The production includes 189,300 tons of hematite, 251,200 tons of basic, 108,300 tons of foundry, and 21,300 tons of forge pig iron. Production of steel ingots and castings in March amounted to 859,900 tons, compared with 774,900 tons in February and 793,300 tons in March, 1928.

CONSTRUCTIONAL WORKS ON THE NICE-CONI TRANSALPINE RAILWAY

(*For description see page 429*)



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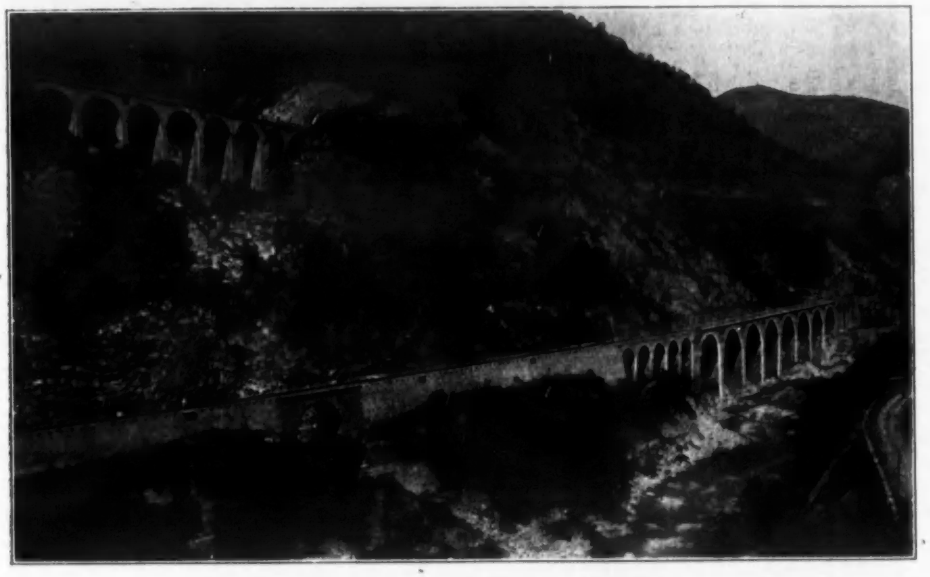

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DEATH.

April 10th, ARTHUR MARTIN, joint managing director of Martin Bros. (Machinery), Ltd., of Manchester, from small-pox contracted while on a return voyage in the ss. "Tuscania" from a business trip to the East.

ANNOUNCEMENT.

On May 1st the amalgamation will take place of "The Engineer," Ltd., of 33, *Norfolk-street, Strand, W.C.* 2, *proprietors of "The Engineer" (founded in* 1856), *with Morgan Bros. (Publishers), Ltd., of* 42, *Cannon-street, E.C., proprietors of "The Ironmonger" and "The Chemist and Druggist" (both founded in* 1859).

The amalgamation will take the form of the incorporation of a new Company with a capital of £500,000, *to be called Morgan Bros. (Publishers), Ltd., with registered offices at* 42, *Cannon-street, E.C., which will acquire the three journals from their present proprietors. All the issued capital of the new company will be allotted to Shareholders in the two amalgamating Companies, and none will be offered to the public for subscription. The Directors of the new Company, all of whom are sons, grandsons or great-grandsons, of the founders of the two businesses, will consist of the Directors of the two amalgamating Companies, and the Chairman will be Sir Gerald E. Chadwyck-Healey, Bart., C.B.E., now Chairman of "The Engineer," Ltd.*

The publishing offices of these journals will for the present remain unchanged, and the policy which has for so many years inspired their management and editorial staffs will be maintained.

THE ENGINEER.

APRIL 19, 1929.

Operating Experiences with High Pressure Steam.

THE account given by Mr. Moultrop of his experiences with the actual operation of steam power plant at pressures of 1200 lb. and over, which we reproduce elsewhere in this issue, will be studied with interest by all central station engineers. When the decision to proceed with the second installation of high-pressure plant at the Edgar Power Station was announced, it was evident that if any troubles had been encountered they were not sufficiently serious to counterbalance the advantages of the higher pressure. Mr. Moultrop, with the broadmindedness we have almost come to expect from American engineers, has now stated exactly what difficulties have been met with since the plant was started over three years ago, and in so doing he has rendered a genuine service to others entering a field where unknown pitfalls may be feared. As we have often pointed out, the improvement of steam conditions is the only road opening up any prospect of advance in steam engineering, and the men who blaze the trail for others are more to be commended than those who venture, perhaps, further but conceal their tracks. The story of the Edgar Station is welcome, apart from its interest. It will serve to hearten those who "let 'I dare not' wait upon 'I would,'" and it justifies our own standpoint with regard to the practicability and economy of much higher pressures than are now common.

An examination of the incidents recorded by Mr. Moultrop shows first of all how often even the most experienced designer takes great precautions to combat troubles which never arrive. Machinery in some ways is most curious, sometimes behaving well in spite of every probability, while committing unexpected offences where good conduct is felt to be certain. At Edgar the designer would have been held culpable if he had not foreseen the cutting effect of steam at 1200 lb. pressure on the seats of safety valves, and had omitted to safeguard the valves. For some reason or other, however, the valves were not cut and the pilot valves, provided as safeguards, were found so unnecessary that they were taken out. Whether a similar happy experience would be found in other installations we should not like to say. Everything would seem to depend on the design of the safety valves, but anyone who knows what a jet of high-pressure steam can do in the way of cutting, and who realises how intractable a thing is a leaky high-pressure safety valve, will be inclined to keep on the safe side till more experience is available. The needlessness of the precautions taken against excessive superheat and of the special design of the alternator to facilitate synchronising are further examples of the failure of expected troubles to materialise. On the other hand, the destruction of the carbon packing in the glands of the first turbine is something which, though naturally not anticipated, did occur. It will be somewhat surprising to engineers conversant with high-pressure turbine practice that carbon packing was even partially adopted, for all experience on this side of the Atlantic points to the advisability of labyrinth packing when the conditions are severe. The packing of turbine spindles against high-pressure steam presents no very great difficulty, especially as full boiler pressure and temperature never come on the packing. With the spindles of centrifugal boiler feed pumps the problem is much more difficult, though it would seem from Mr. Moultrop's statement that labyrinth packing affords a solution. The trouble experienced at Edgar with the hydraulic balancing device of the feed pumps will be sympathised with by many users of pumps for much lower pressures. Hydraulic balancing is all very well in theory, but in practice it can be anything but perfect, so that the provision of an efficient modern design of thrust block to take the whole, or at least the residual, end thrust is indicated in all high-pressure centrifugal feed pumps. The high-pressure turbines in the Edgar Station both show a creditable record, the first running 16,042 hours out of a total of 26,928, and the second 3300 hours out of a possible 8784, both being available for duty nearly 100 per cent. of the time. The blade corrosion and nozzle deposits found in the first machine after three years' service could be paralleled by numberless turbines working at ordinary pressures. Cracked blades, too, are not peculiar to high-pressure work. All these are infirmities to which impulse machines generally are liable, and that they have not been more severely felt at Edgar than in hundreds of low-pressure plants must be counted as satisfactory. One other turbine trouble must be noticed, though it is principally interesting from the steps taken to cure it. We refer to the leakage along the horizontal joint of the second high-pressure turbine when put into service. The fact is one which an engineer less candid than Mr. Moultrop might have been tempted to suppress, and its inclusion testifies to the value of his paper. Why the thinning of the flanges should have abated the leakage is not very obvious. The shorter bolts could certainly not stretch so much as the longer, but on the other hand the flanges and the casings themselves could spring more. The general practice is to use thicker and thicker flanges to maintain

rigidity as pressures increase. The turbine makers appear definitely to have sought greater flexibility as a means of avoiding leakage, which opens up interesting questions of design. One of the troubles which certainly could not have been expected was the discovery that the pressure drop between the boiler and turbine in the first installation was excessive. So heavy, in fact, was it that the turbine could not get the required amount of steam, and the boiler, not being able to dispose of its full output, had to be run at less than its capacity. One hesitates to attribute this great pressure drop to a commonplace mistake in computing the size of pipe required, because such a mistake is unlikely in the case of a so much studied plant. The designer may have been hampered by the desire not to exceed a particular size of pipe, or by the necessity of confining himself to particular valves and fittings, but it is clear that the pipe did not pass as much steam as he intended it should. That there is any great significance in the fact we do not assert, but we believe that a similar phenomenon has been observed in the case of other high-pressure plants, and it may be that our knowledge of the laws of steam flow under conditions of high density may be less perfect than is thought. At Edgar the second boiler installation was designed for a normal working pressure of 1400 lb. in order to provide 1200 lb. at the turbine stop valve, but whether the original steam velocity through the pipes was adhered to or not we are not told. As regards troubles with the boilers themselves, the one thing that experience has emphasised is the necessity for adequate circulation both of steam and water under all conditions over their respective heat-absorbing surfaces. The "faulty steam distribution" which was responsible for the failure of superheater tubes when the plant was new is only another way of saying that the circulation through some of the tubes was deficient. Again, the burning out of tubes when a suddenly diminished demand for steam checked the flow through the superheater shows how important it is that the circulation shall be maintained. Even the cessation of the flow for the few moments required for the pressure to rise sufficiently to lift the safety valves was fatal to the tubes. Nothing is said about the protection of the superheater when starting up the boiler and before the normal steam flow through it is established. It was under these conditions that trouble was met with at Langerbrugge, where the steam temperature is exceptionally high; the difficulty being got over there by passing auxiliary steam through the superheater during the dangerous period. With regard to water tubes, it would appear that two have burst and several were injured by heat during the fifteen months or so since the 1400 lb. boilers were put into service at Edgar. The first case of rupture was definitely attributed by the boilermakers to bad circulation, and steps were taken to improve this. In the second case "blow-torch action" of the flame was blamed, though Mr. Moultrop does not conceal his opinion that a failure of circulation was the more likely cause. Again, although the injury to other tubes was accounted for by localisation of heating owing to slag accumulation, it is significant that the cure determined on was the increase of the circulation through the tubes in question. With high pressures, high temperatures, and especially with high rates of evaporation, the problem of ensuring rapid circulation through all parts of the boiler is becoming more insistent, and, once satisfactorily solved, it is likely that protection of tubes by refractory or metal blocks will be found, not only unnecessary, but positively harmful to the highest duty.

The conclusions of Mr. Moultrop, from his own experience, are that the use of steam at 1200 lb. pressure is entirely practical for power station work and that it does actually give the efficiencies expected. This last point is particularly reassuring, for were the benefits illusory the practicability becomes of academic interest only. The opinions of users of high-pressure steam are worth more than all the calculations in the world as to what is or is not to be gained by increasing pressures, and these opinions, so far as we know, all bear out the view that the advantages outweigh the difficulties. From the figures given by Mr. Moultrop it would appear that the 350 lb. section of the Edgar Station is running with a thermal efficiency of about 23·8 per cent. This is exceedingly good and quite high enough to tempt many engineers to rest satisfied with the pressure. When the full high-pressure equipment is installed, so that all the 350 lb. turbines are driven by the exhaust of 1200 lb. sets, a thermal efficiency of practically 27 per cent. is counted upon, the fuel consumption being 0·9 lb. of 14,050 B.Th.U. coal per kilowatt-hour. For an efficiency of this order one can forgive a few development troubles, even had they been of much more consequence than those experienced at Edgar.

Railway Operation in Fog.

THE fatal collision of January 8th at Ashchurch differed from the five serious accidents of last year in that there was some excuse for it. The up mail train had called at Cheltenham, 7 miles south of Ashchurch, where the weather was inclined to be hazy, and passed through Cleeve—halfway to Ashchurch—where the weather was much the same as at Cheltenham, and then ran into a bank of dense fog, which was aggravated by smoke from a goods train travelling in the opposite direction. The fog had come on suddenly; the fog signalmen had, however, been sent for half-an-hour before the mail passed, but had not arrived. Hence driver Crabtree of the mail had no warning of the condition of the distant signal or of the outer home signal, situated 1346 and 449 yards respectively from the inner home signals at Ashchurch Junction box. All those signals were "on" against the mail, as a shunt of twenty-four wagons was being propelled from the up to the down line through a cross-over road at Ashchurch Level Crossing box 368 yards further on. Crabtree was, unfortunately, killed, and it is unknown whether he lost his bearings or was misled, by his fireman resuming firing, into believing that that man had seen the distant at "clear," or whether, like his fireman, he thought that the detonator his engine exploded at the inner home signal intimated that the distant was being passed. Besides the distant and the outer home signals there were at least five landmarks which ought to have advised the driver where he was. He was spoken of by the assistant to the motive power superintendent as a "stolid, slow-thinking man," and Colonel Mount says that, "Though an experienced driver, with a good knowledge of this road, it would seem that Crabtree may not have been so receptive as others by accustoming himself to, and memorising, less significant objects, such as these, in relation to signal location." In the summary of his remarks and recommendations the Inspecting Officer says that the man probably also failed to realise the situation when, at night, he unexpectedly entered dense fog.

There are, however, certain aspects of this case which show that the cause of the accident did not lie wholly at the door of the unfortunate driver. Our very method of fog signalling may, as we had occasion to point out more than once in former days when collisions in fog were more frequent than now, lead to disaster. Drivers are warned in fog that the distant is "on" by the explosion of a detonator; a clear road is marked by the absence of an explosion. Had the fogmen been on duty at the distant and outer home signals in question, and had those signals been at "clear," driver Crabtree would have heard no explosion. Is it not possible that the absence of an explosion on this occasion, remembering particularly that he did not know that the fog had come on suddenly and that the fogmen were not on duty, caused the driver to assume that he had a clear road? We are not overlooking Rule 144, which tells the driver that unless he sees the fog signalman's green hand signal he must assume that the signal is at "danger" and act accordingly. In spite of it, the anomaly remains that no explosion occurs when the signal is at "clear" and, therefore, it is obvious that the absence of warning might lead a "stolid, slow-thinking man" to wonder if he had a clear road. As Colonel Mount remarks, "hesitation for no more than 30 seconds . . . would have brought him to the outer home, and therefore into the danger zone, before he realised it. A few more seconds and matters were beyond recovery." When the fogmen were called out the man for the distant—obviously the most important signal—was the fifth man to be reached by the messenger, and he lived 3 miles from the fourth man, so that it was a full hour before he was reached. An equally bad arrangement was that the man who lived in the gate-house 444 yards from the distant signal was posted to the distant for the down line, 1½ miles away. Had there been telephonic communication with the two gate-houses "it is possible," Colonel Mount says, "that both the distant and outer home signals could have been served by the time the train arrived and by such means, also, the accident might presumably have been prevented." A decided weakness in block signalling was also revealed. At Ashchurch there are, as will have been gathered, two signal-boxes, and the shunting movement was being made at the more northerly of the two. The cross-over in question is only 230 yards from the more southern box, and had the connections been concentrated, as is possible, in one box the mail would not have been accepted in such weather, and with the fogmen not on duty, but would have been pulled up at Cleeve, where the signalman on duty at the time said that he could see his starting signal, which is 350 yards away. Colonel Mount, in recording that the regulations in this matter have now been modified so as to provide greater safety, recommends that corresponding consideration be given to other situations where such short sections exist. Then, lastly, the standard block regulations include a rule that when a line is about to be obstructed by a train being backed on to it, the block instrument for the line which will be fouled shall be made to indicate "train on line." That, in effect means that before the man at Ashchurch Level Crossing allowed the goods train to come out from the siding on to the up line and then to back along the latter to the cross-over he would have caused the needle of the block instrument in Ashchurch Junction to indicate "train on line" and the man there would not then have been justified in allowing the mail to leave Cleeve. But, as Colonel Mount remarks in the "description" in the early pages of his report, "The use of the blocking-back-inside-home-signal block telegraph signal is not authorised on this, a portion of the Midland, division of the system."

It only remains to be said that the report, reiterating what was said in a leading article in our issue of December 7th last, remarks that during the last thirty years more, perhaps, has been done towards the protection of the signalmen from error than towards assisting the driver in that respect. We are compelled, too, to agree that the present accident confirms the utility of automatic train control, as affording, under modern conditions, desirable assistance to the driver, particularly when running in fog. As Colonel Mount observes, a system like that which is installed at the distant signal on some sections of the Great Western Railway would assuredly have prevented this accident. We may mention also that it is recorded of an all-steel van which was the fifth vehicle on the train, that, whilst the four in front of it and the four in its rear were destroyed, the damage it received was repairable. Of the sixteen windows nine were not even cracked, and, except two which were wrenched off, all the doors worked quite freely or merely required slight force to open them inwards owing to jamming on the floor. There were only four passenger-carrying vehicles and they, with four vans, were electrically lighted; the remaining six were gas lighted, but there was no fire from the gas that escaped from fractured pipes. It would be imprudent to make any sweeping deductions from these facts; on another occasion the wooden coaches may catch fire and the steel coaches be crumpled up. The results of accidents are hard to foresee. Recently a collision was "staged" for a film. A real passenger train, travelling at high speed, was violently derailed by the "accident." The coaches were thrown hither and thither, several being overturned. Yet not a window was broken, and the operators had to go round and break them with hammers to make the picture look like the "truth"!

Obituary.

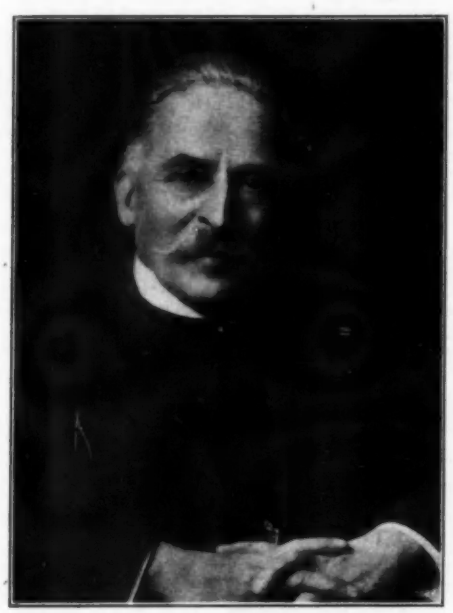
WILLIAM WORBY BEAUMONT.

FOR many years W. W. Beaumont, whose death on April 14th, after a long illness, we have to record with deep regret, was a familiar personality amongst engineers. Even those who had not the advantage of his acquaintance remembered him by a little affectation in dress and by the studied deliberation with which he spoke. In the latter part of his life he frequently appeared as an expert witness, and it is said that in the box he was absolutely imperturbable. Even the most provocative counsel could not move him to say a hurried word or to give an opinion before he had duly weighed the premises. He was, in a sense, a reserved man, and only those who knew him really intimately were ever given an opportunity of learning the depth of a character which had in it much to inspire affection. He had a small circle of such friends, and with them he expanded in a way that would have surprised those who knew him but superficially. Of the many kindnesses he did, few but himself were aware, for he indeed took care that his right hand should not know what his left hand did.

He was an engineer by instinct, inherited, no doubt,

in part from that William Worby, his grandfather, whose name is still remembered in Ipswich, where for years he was works manager at Ransomes, Sims and Jefferies. Beaumont was born near Manchester, but was never a Manchester man. He received his early training at the Reading Ironworks in the manner customary in the 'fifties and 'sixties of last century. That is to say, he became an engineer by first becoming a workman—not a bad plan at all. Whilst there he saw a good deal of the experimental work on the Lenoir gas engine and acquired an interest for internal combustion engines which he retained through after years. His education must have been scanty, and much of it must have been acquired by private study. But it was a very serviceable education. Not a mathematician, he could use workshop arithmetic as few, if any, modern engineers can do, and could reach a right conclusion by simple means. As his calculations were always controlled by that inherent mechanical instinct which is now an almost defunct quality, he rarely made a mistake. Throughout life he maintained, too, his skill of hand, and for an invention, or to illustrate an argument in court, turned out his own models with the simplest tools.

He is known as the inventor of the Vibromotor, which at one time was largely used. But he made little of it commercially. Indeed, it is said that he received more as the result of the infringement of his patent for vibro-massage than he made by all its original applications. It is interesting as an example of the intelligent use of observation. He saw how difficult it was to keep vibrations out of quickly rotating masses, and by a stroke of genius turned a defect towards a useful purpose. The Vibromotor was nothing more than an unbalanced weight on a high-speed spindle. By the proper application of that



William Worby Beaumont

simple device it was possible to give a vibratory action to sieves and screens for all sorts of purposes, and it was used fairly extensively at one time in paper mills and flour mills and for coal screening. It was characteristic of Beaumont that as soon as the Vibromotor had been brought to perfection he lost interest in it.

Another invention of his which was due also to simple observation was a solid rubber tire for vehicles. He had observed that in practice tires wore hollow, and to counteract that defect he laminated them by a series of circular grooves on the outer faces. The grooves weakened the resistance, so to speak, of the edges, and the wear took place more uniformly. In the case of both these inventions the lack of the commercial spirit prevented the success which they might have achieved in other hands.

After Beaumont left Ipswich he was associated for some years with Robert Mallet, from whom he acquired a taste for civil engineering and particularly for bridge design and incidentally for architecture. Robert Mallet was a frequent contributor to The Engineer in those days, and it was perhaps through him that Beaumont joined the editorial staff of The Engineer. He remained with this paper for ten years, leaving it over thirty years ago to set up in consulting practice. He was best known in connection with road transport and received an appointment as technical adviser to the Commissioner of Police on all motor vehicle questions. He was Vice-Chairman of the Roads Improvement Association and the author of two or three notable works on motor car design. He was a founder member of the Royal Automobile Club and its Hon. Consulting Engineer. But it must not be thought, as so many people seemed to think, that he was solely a motor car man. His interests were much wider, and he was acknowledged as an expert in paper mill and saw mill machinery, and indeed in all those subjects which at one time would have been classed under millwrighting. We are reminded that he took a keen interest in electrical engineering in its early days, and students of that subject thirty or forty years ago will recall a little primer on it, in which he showed his ability for expressing facts in a simple and easily comprehended form. He was a member of the Institution of Civil and Mechanical Engineers, a Past-President of the Society of Engineers, a member of the Institution of Electrical Engineers and of other bodies. But we believe that he served on the Councils of few, if any. The fact is that he was rather intolerant of the restraint of committees and that he did not collaborate willingly.

To conclude any memoir of "W. W. B.," as he was familiarly known, without mentioning a characteristic which impressed itself upon the attention would be impossible. It was his almost total indifference to the conventional division of day and night. He would begin work when the rest of the world was thinking about luncheon and go to bed when the dawn was breaking. The fact is that he worked best in the still hours of the night and made as much of them as he could.

He was over eighty at the time of his death, and as he had been an engineer from the age of fifteen, he had seen and followed most of the remarkable advances of a long and notable period. He belonged to a school which has gone for ever; the school of engineers which was taught by training in the workshop and learnt the science of their profession with little external assistance. In that way very many notable mechanical engineers were made, and we count Beaumont amongst them.

Literature.

The Principles of Underdrainage. By Reginald David Walker, M.C., Assoc. M. Inst. C.E. London: Chapman and Hall, Ltd. 1929. Price 15s.

In the British Isles the principles of soil and ground drainage, whether as applying to local purposes or to considerable areas, have not yet received the attention which their importance warrants. Farm fields have been drained with a large measure of useful effect, but in respect of both the wider operations of land drainage and the execution of civil engineering and building works, the principles and practice of drainage are widely neglected, misinterpreted, or misapplied. This is true of both surface and under drainage, as well as of combinations of both methods; railway and road cuttings affording very conspicuous examples.

There are many cases in which surface and underdrainage are alternatives, one of which should be preferred, because more efficient or less costly than the other. There are also cases calling for combinations of both methods, some of these cases offering the engineer an opportunity of considerably reducing the whole cost of a work to be carried out mainly by one of the methods. It is essential to the economical execution of drainage works generally that these considerations should be duly borne in mind by the engineer.

It is unfortunate, therefore, that Mr. Walker's book, which is a very useful work, should contain suggestions of preferences, of almost partisan character, for methods such as lessen the efficiency and increase the costs of so many works of land drainage. He explains, very intelligently, the principles of underdrainage, and its applications to small valleys, to flat lands, to cuttings, and to the prevention of slips and subsidences; but the value of all this might have been much increased had he written throughout as one aware of the close relation between surface and underground flow, and of the significance of surface drainage in respect of nearly every problem, the solution of which he describes. Some dozen or so of additional pages would have sufficed thus to render his studies and examples more interesting and more informative, while less likely to confuse the minds of young engineers who may, in the book, fail to distinguish the problem in itself from the objects of the measures described.

In Chapter XV., Open Drains and their Uses, the author provides some good elementary data, but does not really discuss or describe the uses of open drains, except as an adjunct to an underdrain system where the gradient is not steep enough for a pipe drain, and as necessary when a ravine is too long and its catchment too large for successful underdrainage, or for that alone. Such examples are important, but it is disappointing to find that they are "... the reasons ..." why it is sometimes "... found desirable to provide open drains to act in conjunction with underdrains. ..." The importance of surface drains, in railway drainage, is stressed, but the matter is not further discussed, though some of the illustrations depicting the application of underdrainage to railway cuttings strongly suggest the importance of surface drainage as a partial or a complete alternative.

As furnishing the guidance needed for a proper understanding of the nature of underdrainage and the means by which it may effectively and economically be carried out, the book conspicuously fulfils a very useful purpose. With the advantage of his experience in carrying out important works such as he describes, the author has been able to present his subject in all essentials. Due consideration is given to elementary matters; principles, definitions, and the occurrence of underground water; upon which foundation the author develops the theory and describes the practice of underdrainage. He somewhat overstresses the significance of the "water table," at the expense of the abiding sense of the hydraulic gradient, or water surface slope underground, the importance of which is seldom realised by engineers in the British Isles. Very good practical guidance is afforded as regards the location of underdrains, anti-malaria drainage, and the application of underdrainage to the cases already mentioned. The economics of the subject are explained, useful information concerning estimates being furnished, with examples in an appendix. There are, throughout the book, sufficient precise data for the purposes of explanation and of application.

Because the principles of underdrainage are not generally understood, or, at least, are neglected by those who might usefully apply them, while the data of the subject are somewhat scanty or scattered, Mr. Walker's sumptuously printed and illustrated book is one which can confidently be recommended to engineers who may have to deal with cases such as he describes, that is, nearly all civil engineers, more especially and indeed emphatically to the railway and highway engineers of this country.

Electricity Applied to Coal Mining. By H. Cotton. London: Sir Isaac Pitman and Sons, Ltd. Price 35s.

The subject with which this book deals is one of considerable importance, and although the volume is not the only one of its kind, it has the merit of representing up-to-date practice. The first few chapters deal with generation, transmission, and distribution. No claim to any particular originality is made for these chapters, but the author believes that the method of treatment of the sections dealing with the application of electricity to mining problems is in many cases quite new. The nature of the load, particularly in the case of fan, compressor, and pump drives, has been investigated with sufficient completeness to give the responsible electrical engineer all the information he will require. In certain cases as, for instance, the rheostatic control of a fan motor, the current taken by a three-throw ram pump and the speed variations in a Ward-Leonard controlled winder, laboratory experiments have been made by the author with small machines in order to demonstrate certain peculiarities which are not immediately obvious. With certain kinds of drives, speed regulation is of considerable importance, and the problem of such regulation with reference to the nature of the drive is fully treated. Some of the matters with which the author deals are of general interest to electrial engineers as well as to those who specialise in the electrification of mines, such, for instance, as the advantages of electric power, the power supply, the generation of electrical energy, and power station control. Much of the control gear which the book describes is applicable to all power stations. For the most part, however, the volume is confined strictly to mining work, and, as we have indicated, useful information is given concerning various forms of electric drive. The transmission and distribution section of the volume is also of considerable value. While fairly extensive use has been made of manufacturers' illustrations, the author has not included lengthy descriptions of things that are well known. In other words, the volume is not made up of material derived from manufacturers' catalogues, but is devoted for the most part to technical considerations which can scarcely fail to prove of value to those interested in the electrification of mines.

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Can We Trade with Russia? By Edouard Luboff. London: Anglo-Russian Press, 23/28, Fleet-street, E.C. 4. Price 1s.

The Merchant Navy. Volume III. By Sir Archibald Hurd. London: John Murray, Albemarle-street, W. Price 21s. net.

Mining Subsidence. By H. Briggs, O.B.E., D.Sc., &c. London: Edward Arnold and Co., Ltd., 41, Maddox-street, W. 1. Price 14s. net.

Sir Joseph Wilson Swan, F.R.S.: A Memoir. By M. E. S. and K. R. S. London: Ernest Benn, Ltd., Bouverie House, 154, Fleet-street, E.C. 4. Price 7s. 6d. net.

The South African Mining and Engineering Year Book and Directory, 1929. London: Argus South African Newspapers, Ltd., 72-78, Fleet-street, E.C. 4. Price 21s. net.

Building Science Abstracts. Vol. II., new series. No. 2. Abstracts 201-399. Department of Scientific and Industrial Research. London: H.M. Stationery Office. Price 9d. net.

The Coal Industry of the Eighteenth Century. By T. S. Ashton, M.A., and J. Sykes, M.A. Manchester: The Manchester University Press, 23, Lime-grove, Oxford-road. Price 14s. net.

Brassey's Naval and Shipping Annual, 1929. Edited by Commander C. N. Robinson, R.N., and A. J. W. Burgess, R.I., R.O.I. London: William Clowes and Sons, Ltd., 94, Jermyn-street, S.W. 1. Price 25s. net.

The Alouette Hydro-Electric Generating Station.

THE British Columbia Electric Railway Company owns and operates all the power supply industry on the Pacific Coasts' district of British Columbia and the southern portion of Vancouver Island. The mainland power stations, including that at Alouette, have a total installed capacity of 135,825 kVA, of which all but 12,500 kVA are generated by water power. Nearly half of this total is installed in the Stave Lake power station, lying at the foot of Stave Lake. The growing demand necessitated further power being generated, and accordingly it was decided to utilise the water of Alouette Lake, lying in a neighbouring valley to Stave Lake. The outlet to Alouette Lake was dammed to increase its storage capacity and a tunnel driven through the narrow rim which separates the two lakes at the upper end. In addition to rendering a further supply of water available at Stave Lake power station, the installation of a new power station was rendered possible by the fact that the level of the dammed Alouette Lake was appreciably higher than that of Stave Lake. The Alouette power station, shown in Fig. 1, is situated at the Stave Lake end of the tunnel between the two lakes, and a single unit, generating 10,000 kVA, is installed in this power station.

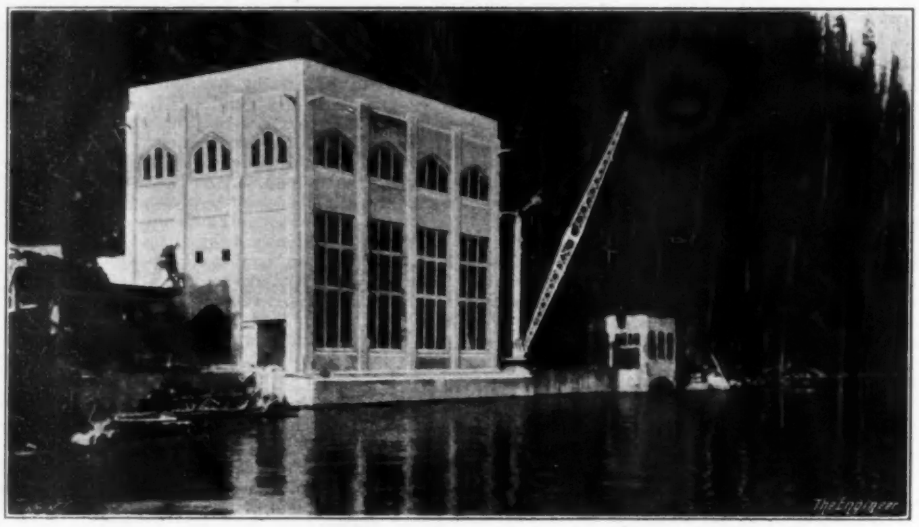


FIG. 1—THE ALOUETTE HYDRO-ELECTRIC POWER STATION

Stave Lake power station and the station at Alouette are about 10½ miles apart, and Alouette has been arranged as an automatic generating station, controlled from Stave Lake. The whole output of the Alouette station is transmitted to the bus-bars at Stave Lake and the mere closing of the oil switch in the incoming line from Alouette causes the set at Alouette to start up, synchronise and supply power to the system. The opening of the same breaker causes the Alouette station to shut down.

The tunnel between Alouette and Stave Lake terminates in a surge chamber, from the bottom of which the penstock, 12ft. diameter, is taken through the solid rock to the power-house. The shore of the lake consists of rock, and as it slopes steeply to the water's edge the whole layout was arranged to give the minimum floor area for the power station and so to reduce the very costly excavation involved. The set—see Figs. 2, 3 and 4—is of the vertical shaft type, which, in addition to being most suitable for the local hydraulic conditions, enabled a very much reduced floor area to be employed. The level of Alouette Lake varies between 437ft. and 485ft., while the level of Stave Lake may vary between 300ft. and 340ft. The draft tube seal is at 314ft. The average head at Alouette will then be 138·4ft., but will normally vary between 124ft. and 154ft. The extreme limits of variation of head are between 97ft. and 171ft.

The power station is of the two-storey type and the turbine, main valve, &c., are situated on the lower or turbine floor, these parts being erected before the upper or generator floor was built. The latter has to carry the entire weight of the generator and also the turbine thrust, and had to be made exceptionally stiff. Two girders, 72in. deep, span the power-house, and are joined by two 36in. girders to form a massive frame for supporting the weight.

The turbine is of the vertical shaft reaction type, having a normal output of 12,500 brake horse-power and running at 200 revolutions per minute, whilst the maximum output is 14,300 brake horse-power, giving an overload capacity of about 15 per cent. The guaranteed efficiency between three-quarter, full load, and maximum overload varies between 88 per cent. and 89 per cent. Tests at site showed that the turbine efficiency was well over guarantee and reached a maximum of 91 per cent. Curves giving the turbine and generator efficiencies are shown in Figs. 5 and 6 respectively. The whole of the set, including the main 12ft. diameter valve, turbine, alternator and exciter, and also a standby turbine driven exciter set, were manufactured by the English Electric Company. The water supply to the turbine is controlled by an English Electric cylindrical balanced streamline type valve—see Fig. 7. The upstream diameter of this valve is 12ft. and it is bolted to the lower end of the penstock, while the downstream side which has a diameter of 8ft. is bolted direct to the entrance of the spiral casing. The special features of this type of valve are as follows:—(1) The opening and closing movements of the valve are performed by water pressure and are under absolute control. Both these movements are automatically controlled; the final closing and initial opening movements take place very slowly, thus rendering slam-shutting or slam-opening impossible; (2) the whole of the control mechanism is outside the valve and is thus readily accessible for adjustment and maintenance; (3) a dismantling ring is provided which enables any slight discrepancy in the distance between the downstream flange of the penstock and the entrance flange to the spiral casing to be taken up; moreover, as the body of the valve is made in two portions, the valve can be dismantled by the power station crane, an opening in the generator floor being provided for this purpose. Normally this opening is covered by a hatchway formed of girders and chequer plating. The valve is designed for hand control and for electric control in connection with the automatic running of the station. In the normal operating condition it weighs over 80 tons.

The spiral casing of the turbine is built up of steel plate riveted together and to a massive cast steel speed ring. The casing and speed ring are together divided into three portions to reduce the weight and dimensions to values suitable for shipping purposes. The casing is designed as a logarithmic spiral to give a correct intake vortex and to ensure that the water is led to the runner in the best and most efficient manner without the formation of eddies, and it is heavily reinforced and embedded in concrete up to its upper surface.

At the maker's works the spiral casing was tested to a pressure 50 per cent. higher than the maximum possible static head. The supply of water to the runner is controlled by a number of swivel gates of cast steel, cast in one piece with the stem and designed to a perfect streamline form. A machined strip is provided along the length of each gate, against which a similar machined strip on the neighbouring gate bears when closed. Each gate is supported by a suspension bearing at its upper end and by grease-lubricated journal bearings rotating in bronze bushes. The upper end of each gate stem is connected by a lever and a breaking link to the main regulating ring, the rotation of which opens or closes all the gates simultaneously. The breaking links are of cast iron and are so arranged that in the event of any foreign body getting between the gates they will break before any other portion of the mechanism is unduly stressed, a supply of spare links being kept available.

The main regulating ring is carried on the turbine cover, which is an iron casting made in two parts for erection purposes. Fig. 8 shows the servo motor and guide vanes, whilst Fig. 9 shows the servo motor separately. In addition to carrying the regulating apparatus, the main cover supports the stuffing-box, designed to prevent water leaking along the shaft, and also the turbine guide bearing. The main guide bearing is of the white metal-lined type, amply proportioned and is lubricated by an oil pump driven from the main shaft by gearing. The main shaft is of forged steel, having a coupling flange forged solid at each end, one for coupling to the runner and the other for coupling to the alternator shaft. The torque is transmitted to and from the turbine shaft by keys, accurately fitted and laid in transverse keyways cut across the face of the couplings. The coupling faces are held together by bolts, but these have a clearance fit and are not subjected to torque, a form of construction which ensures that no part has to bear unnecessary stresses.

The runner—see Fig. 10—coupled to the lower end of the shaft is made of fine-grained homogeneous cast iron and is accurately designed with a view to obtaining the maximum possible efficiency. The vanes are very carefully streamlined. Forged steel sealing rings are shrunk on to the runner and form a very effective labyrinth seal and reduce water leakages past the runner to a minimum. The draught tube below the runner is of the English Electric special spreading type, designed to take full advantage of the available suction head with a minimum of loss. The lower part of the draught tube where the water velocity is low is cast in concrete, but the upper part, nearest the runner where velocities are necessarily higher, is made of cast iron and sheet steel. In this upper portion a dismantling piece is arranged to allow the removal of the runner in the following way:—The dismantling piece of the draught tube can be removed along a gallery provided for the purpose and lifted through an opening provided in

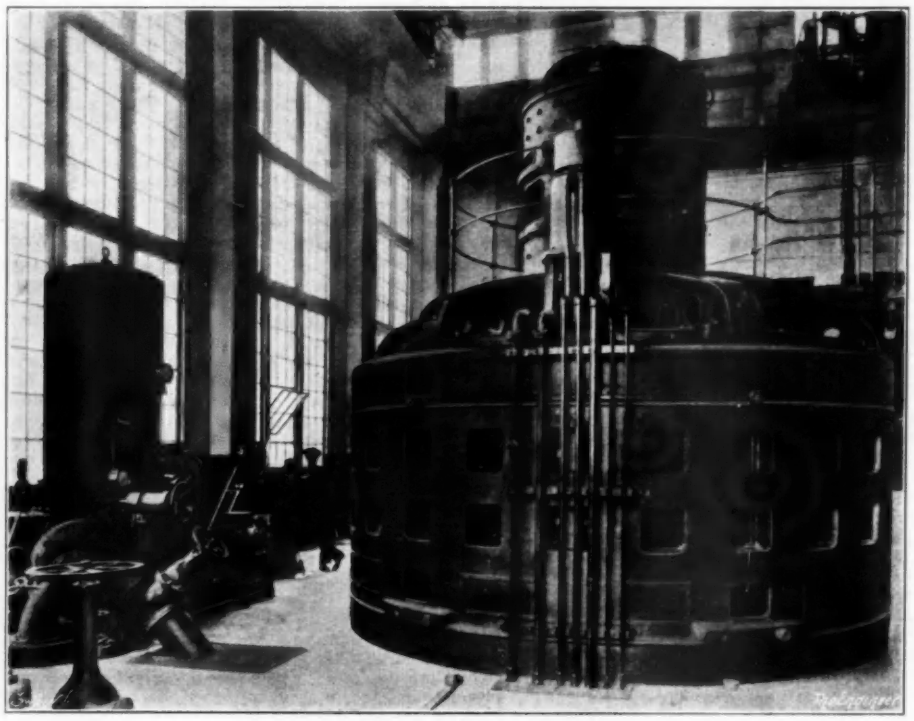


FIG. 2—10,000 kVA GENERATING SET

the turbine floor. There is a similar opening in the alternator floor so that the main crane can be used for removing the runner. Rails are then laid across the draught tube and after removing the dismantling ring the runner can be slung from the main crane through a hole in the shaft and placed on a special trolley carried on the rails spanning the draught tube. It can then be removed to the pit and be handled by the main crane.

The speed governor is of the oil pressure operated automatic type and consists of (*a*) the oil pump and pressure receiver—see Fig. 11—(*b*) the actuator and auxiliary servo motor, and (*c*) the main servo motor.

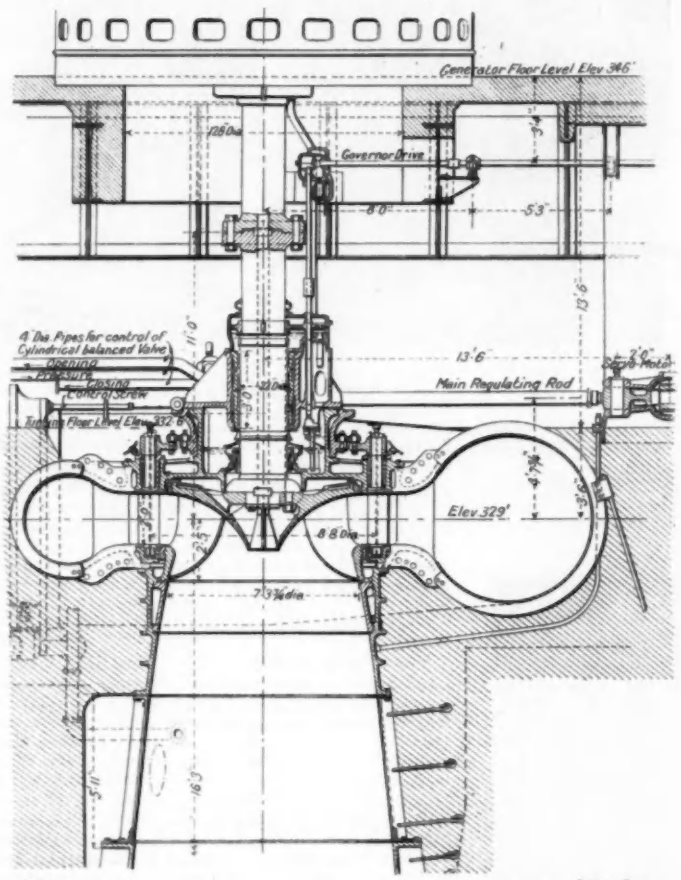


FIG. 3—SECTION THROUGH 10,000 kVA TURBINE

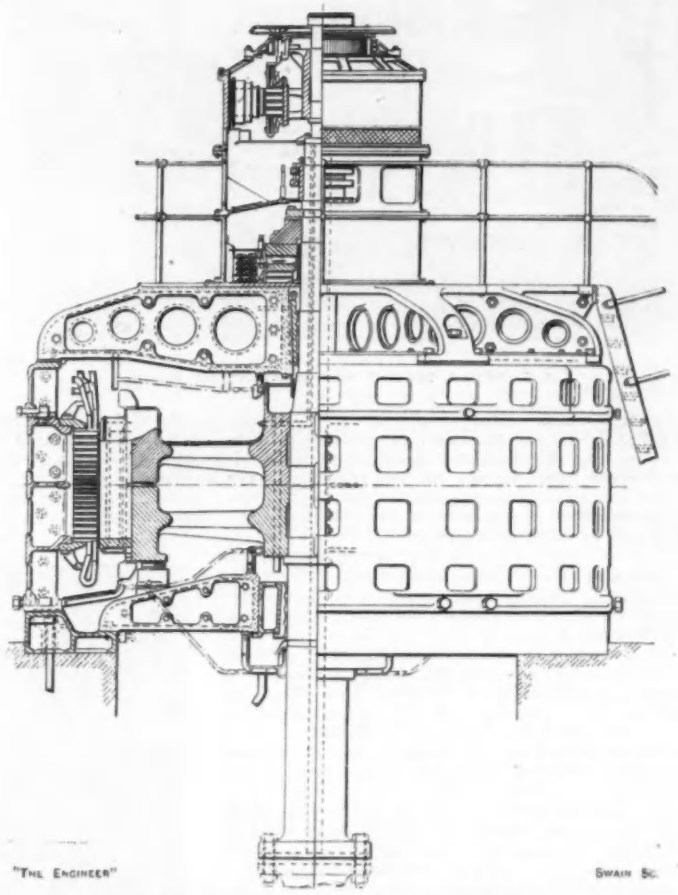


FIG. 4—ARRANGEMENT OF 10,000 kVA GENERATOR

The oil pump is of the single-stage gear type and is driven by an automatically controlled auxiliary turbine, the control being arranged so that when the oil pressure drops the turbine gates are opened and the oil pump then runs until the pressure receiver is replenished. A motor, also automatically controlled, is provided as a standby. The correct level is maintained in the pressure receiver by a motor-driven air compressor, which is also automatically controlled so that the right amount of oil at the correct pressure is always available for operating the governor.

The actuator and auxiliary servo motor are on the generator floor. The pendulum is driven from the

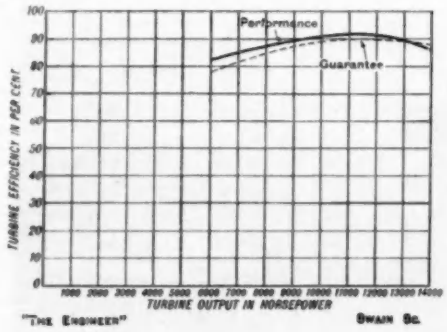


FIG. 5—TURBINE EFFICIENCY CURVES

main shaft and is of the spring-controlled type and controls a pilot valve which, in case of variation of speed, admits oil to one side or the other of the auxiliary servo motor. The main servo motor, which is on the turbine, operates the turbine gates by the regulating ring and two regulating rods to be seen in Fig. 8. Oil is admitted to one side or the other of the main servo motor by the action of the auxiliary servo motor on the generator floor. Special devices fitted to the governor for automatic control will be described in detail later.

The alternator is of the vertical shaft type having an output of 10,000 kVA at a power factor 0·8, and 6825/7500 volts when driven by the turbine at 200 revolutions per minute. It is carried on a ring type bed-plate which carries the stator, and also the lower bracket supporting the lower guide bearing and brakes. The upper bracket, which is a massive iron casting, is supported from the stator and carries the thrust bearing, brush gear and exciter. Access to these parts can be obtained by a ladder from the floor level or by a bridge gangway from the switchboard gallery, which is at the same level. The stator core consists of thin laminations of silicon steel carried in and keyed to the massive cast iron frame. The winding is of the double layer lap type, mica insulated throughout and inserted in slots stamped in the inner periphery of the core. This type of winding permits the use of fractional slot windings and has the effect of reducing higher harmonics in the wave form to an insignificant value. The overhang can be very securely braced against the forces arising on short circuit. Losses are reduced to a minimum by suitable lamination of the conductors.

The rotor body consists of two steel castings shrunk on to the shaft. A relatively heavy interference fit is necessary to ensure contact between the rotor and the shaft at overspeed, and to avoid the use of a heavy hydraulic press, and consequent risk of damage to the shaft, the following method of assembly is employed. The rotor wheels are heated by eddy

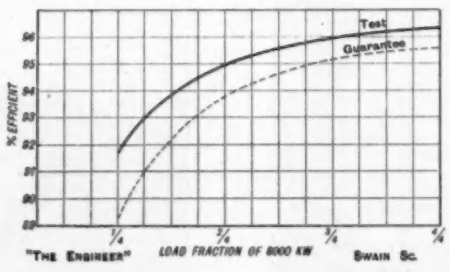


FIG. 6—GENERATOR EFFICIENCY CURVES

currents induced in them by a coil wound round the rim and the hub, the heating being under perfect control, and when the necessary expansion is obtained the shaft can be inserted without difficulty. This method was also used for removing the wheels from the shaft for shipment and again in the final assembly at site. The poles are built up of stamped laminations, dovetailed to the rotor. Fitted side keys are used in the dovetails, thus ensuring a perfect fit and eliminating the necessity of heavy pole pressing tackle. The rotor coils are of copper strip, insulated throughout with mica and Class "B" material, and are mounted on spools. During manufacture the coils were subjected to a pressure well in excess of that obtaining on overspeed. They are held in position by the polar horn which is also used to obtain a suitable distribution of flux. The whole weight of the rotating parts of the alternator and the turbine and the hydraulic thrust, amounting to about 120 tons, is carried by a Michell thrust bearing which is immersed in an oil bath and automatically sets up its own oil circulation. A supply of cooling water is circulated through a copper coil in the oil bath.

The guide bearings are of the journal type, consisting of Babbitted cast iron in bushes carried in the upper and lower brackets. Oil is supplied by a pump gear driven from the main shaft to a gravity tank on the upper bracket, from which it flows to the upper bearing. The oil discharged from this bearing is collected in a rotating oil pan and led by pipes through the hubs to the lower guide bearing. The oil from the bearing drains to the lower sump, from which the pump draws its supply. At starting, and before the gear-driven pump has filled the gravity tank, a supply is provided by a separate motor-driven pump. The lower bracket also carries the brakes, which consist of cylinders fitted with plungers carrying Ferodo-lined pads which bear on the rotor rim. Except when actually braking, when the plungers are operated by

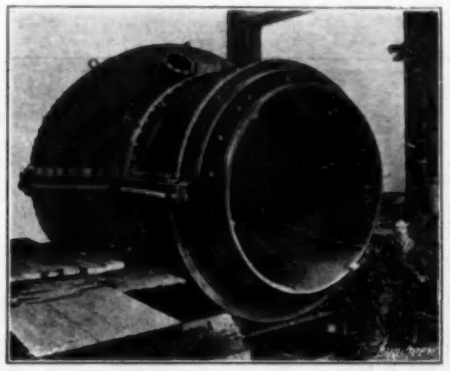


FIG. 7—CYLINDRICAL BALANCED VALVE

compressed air, which overcomes the pressure of the springs and forces the Ferodo pads against the rotor, the brakes are definitely held off by the springs. The cylinders can also be connected to a high-pressure hand-operated oil pump, which jacks up the rotor for inspection of the thrust bearing, &c. On test the alternator took about forty-two minutes to come to rest from full speed running free, but this period was reduced to four minutes by the use of the brakes. The exciter is of the direct-connected vertical shaft type mounted above the slip rings and thrust bearing. The test facilities at the Stafford works of the makers enabled tests to be conducted on the alternator before shipment, the exciter being used as a driving motor for

open circuit, short circuit and overspeed tests. In every respect the machine was up to the specification, while the efficiency calculated from the separate losses, including the stray losses as measured on short circuit and the exciter and rheostat losses, reached at full load the high value of 96·3 per cent., the guaranteed full-load efficiency being 95·6 per cent., as shown in Fig. 6. A turbine-driven standby exciter —see Fig. 12—is also provided. The exciter consists of a standard direct-current generator of the horizontal shaft type running at 900 revolutions per minute, but suitable for the turbine overspeed. The turbine driving this unit is of the reaction type, fitted with an oil pressure governor.

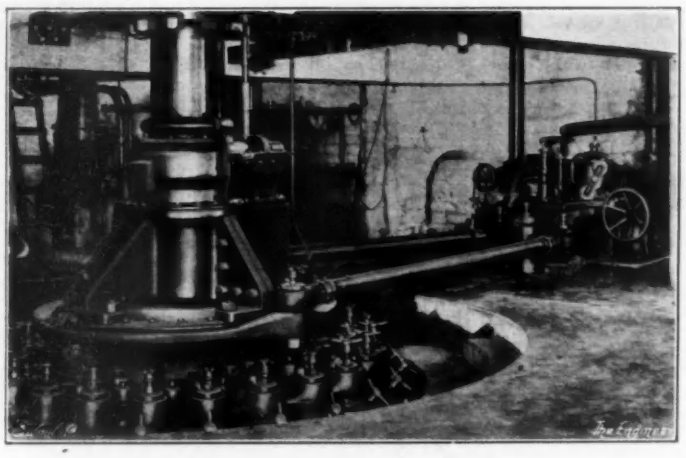


Fig. 8—Servo Motor and Regulating Ring

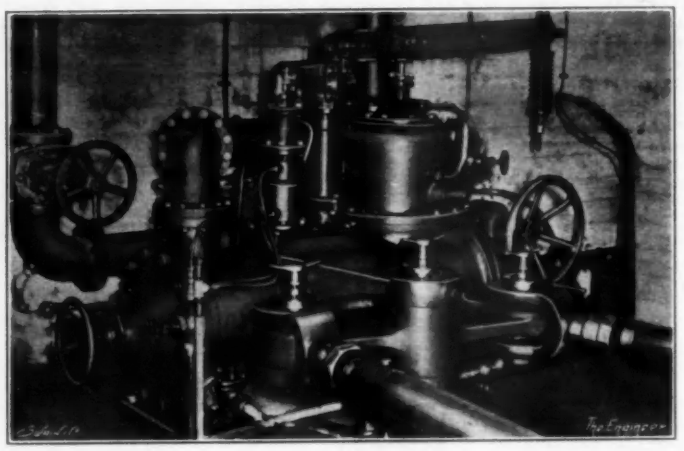


Fig. 9—Servo Motor

As stated previously, the station will be entirely automatic and the whole plant was designed with this end in view. The automatic operation can be divided into three parts :—(1) Starting up, (2) shutting down, (3) protection.

The alternator is connected through an automatic oil switch to the transformers which are connected through an oil switch to the line. The E.H.T. oil switch is always closed, whether the set is running or not. The starting indication is given by closing a breaker at Stave Lake, which makes the line live and energises a potential transformer on low-tension side of the main transformer. If everything is then satisfactory this energises the coil of the under-voltage relay and if the voltage is sufficient this operates and closes the circuit of the master relay, which immediately starts up the motor-driven oil pump and the motor driving the governor oil pump, thus ensuring that an adequate supply of oil is available for the bearings and governor system as soon as the set starts.

The main valve is hydraulically operated, the supply to the operating chamber being controlled by a small electric motor, which is energised from the battery through the master relay and the valve opens about ¼in. and remains in this position until the spiral casing has filled with water, when a hydraulically operated device releases the valve and allows it to open to its full extent. Limit switches are fitted to shut down the valve-operating motor when the valve is fully open and also to give the next operation in the starting sequence. The turbine gates are controlled by the governor, which for the purpose of automatic operation, is fitted with a solenoid. The gates are under the control of the centrifugal pendulum when the solenoid is energised, but otherwise they are closed. Up to this point the solenoid has been dead, but as soon as the valve is fully open it is energised through the limit switch referred to above and the gates open slowly. As the set runs up to speed the governor takes control and the set settles down to normal speed. Meanwhile the exciter voltage has built up, and when it has reached the correct value the exciter relay operates and closes the exciter breaker. As soon as the alternator volts have built up the automatic speed matching and synchronising devices come into action. The speed of the turbine can be varied by plus or minus 5 per cent. from normal by a motor mounted on the actuator. The speed-matching device controls this motor, so that the frequency of the set is brought up to that of the system. As the set comes into synchronism the automatic synchronising device operates and closes the main oil switch. During this period the alternator has been controlled by the automatic voltage regulator, thus ensuring that the minimum disturbance to the system is caused by switching in. The synchronising motor continues to run, thereby causing the speed to tend to rise, but as the set is now tied in synchronism this operation causes the set to take up load. The motor is shut down by a limit switch on the actuator when the desired load setting is obtained. The set will now continue to run on load until it is shut down by the action of the attendant at Stave Lake or by one of the automatic protective devices.

Fig. 10—Turbine Runner

Normally shutting down is effected by opening the oil switch in the Alouette feeder at Stave Lake. The immediate result of this is to reduce the load on the Alouette set to zero and the underload relay after an appropriate delay opens the circuit of the master relay. This de-energises the governor solenoid and the gates close. As the gates pass the no-load position a limit switch causes the oil switch to trip. The master relay in opening also shuts down the governor oil pump and causes the valve-operating motor to rotate in the direction required for closing the main valve. When the valve is closed pressure disappears from the spiral casing, and a water pressure-operated switch closes the circuit-controlling and air-application valve, admitting compressed air to the brake cylinders. After a reasonable interval, during which the set will have come to rest, this valve is reclosed. All the devices are then in the starting position and ready for the next cycle of operations.

The alternator is protected against internal faults by differential protection gear, an over-voltage relay, over-current relay, an excess field current relay, and reverse power relays. Any of these relays on operating trip the main oil switch and field breaker simultaneously and also open the circuit of the master contactor, thus shutting down the turbine. The transformers are similarly protected by differential gear, which, in addition to the above, trips out the oil switch on the high-tension side of the transformers. Further protection is afforded by a thermal relay, which will shut down the set if the temperature of the alternator or of the transformers becomes excessive, and other relays are provided to guard against failure of cooling water to the transformers or an exceptionally low level of lubricating oil in the gravity tank. Thermostats in the bearings are provided to shut down the set in case of high bearing temperatures. The above devices open the circuit of the master relay, thus shutting down the set in the normal manner. Protection at starting is provided by relays which prevent the master relay closing in case of single-phase or reversed-phase rotation on the line, over or under-voltage and over or under-frequency. A time delay relay is fitted which is energised when the starting indication is given and which is de-energised when the oil switch closes. Should any of the starting operations fail after a definite but adequate time interval, this relay will shut down and lock out the station.

Further protection is afforded to shut down the station in the event of the governor drive failing or should the set attempt to run with the brakes applied, or to run at overspeed, or in the event of the governor oil pressure dropping to an unsafe value. Normally

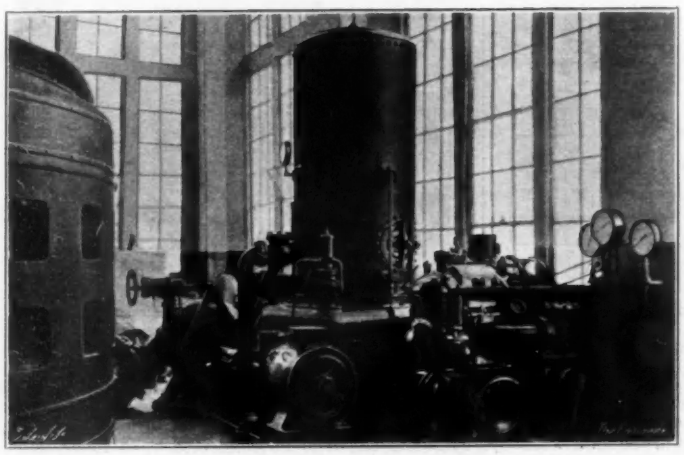


Fig. 11—Oil Pump and Receiver

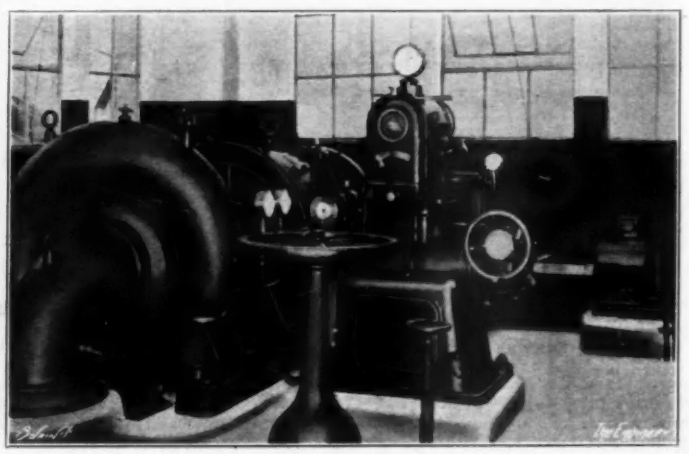


Fig. 12—Exciter Set

the spare exciter is not in use and the whole station is arranged so that it can be operated manually if required.

Normally the governor oil pressure is maintained by the oil pump turbine, which runs continually whether the station is running or not.

The gravity tank is supplied with oil by the gear-driven oil pump, which runs continually when the set is running. The motor-driven oil pump is controlled by a float switch in the gravity tank and maintains the level at the correct position. This pump runs during the starting sequence to ensure an adequate supply of oil when the turbine starts, and it also runs during the period when the set is running down to standstill. The battery used to supply the automatic devices is maintained in a charged condition by an automatic charging set, which runs whenever the main set is in operation.

American Engineering News.

Train-Ferry and Bridge.

A NOTED train-ferry which has been in operation since 1879, will be abandoned in about two years with the completion of the Southern Pacific Railway Bridge across Suisan Bay, on the Sacramento River, which flows beyond the bay into the harbour of San Francisco. The main part of the bridge consists of seven through-truss spans of 530ft. and a vertical lift span of 330ft. over the navigation channel. At the north end is a 500ft. deck truss with plate girder approach spans, while the south end has a 266ft. deck truss span and plate girder viaduct approach. The spans give 70ft. clearance above high water, and the lift span gives a 135ft. clearance for ocean steamers. It will be double-track throughout. Deep foundation work is required, as rock is about 150ft. below the water line. With increasing traffic the ferry has become a bottle-neck, especially with frequent fogs that delay the movement of the ferry boats. And with the greatly increased weights of modern locomotives and cars, the amount of repair and maintenance work on the two old boats becomes excessive. Three new steamers with new landings would be necessary, and the bridge was considered a better investment, though it will cost about £2,400,000. The two famous car-ferry steamers "Solano" and "Contra Costa" are paddle-wheel boats, with engines and boilers on each side of the main deck, on the guards or projecting portion of the deck which is in line with the outside of the paddle boxes. The "Solano" is fifty years old. Each boat carries two locomotives and twenty-four passenger cars, or two locomotives and thirty-six freight cars.

New Aero Engine.

The latest Curtiss engine for military aircraft, rated at 625 H.P., is of the twelve-cylinder type with six cylinders in each row set at 60 deg., and running at 2400 revolutions. The engine is water-cooled, with two high-tension magnetos and two dual type carburetters, and having two spark plugs to each cylinder. The cylinders are of 5½in. in diameter and 6½in. stroke, with a nominal piston displacement of 1569 cubic inches. The fuel consumption at full throttle is 0·53 lb. per hour. This engine, which may be used for direct or geared drive, weighs only 755 lb. Each cylinder has two inlet valves and two exhaust valves, operated by two cam shafts on each cylinder head, driven by nickel-steel bevel gears from the timing gear train. The steel cylinder sleeves are hydraulic forged, rough-machined, heat-treated, finish-machined and finally ground in the bore. The cylinder heads are not removable. Each water jacket serves six cylinders and transmits the explosion forces to the crank shaft, which is of forged chrome-nickel steel and runs in eight bearings. The thrust bearing, of the deep-grooved radial annular ball type, is arranged between the seventh and eighth main bearings, and takes thrust in either direction. All drive shafts and gears in the gear case are of forged nickel steel. Aluminium alloy castings of the ribbed head type are used for the pistons, with pins of nickel-alloy floating in the pistons and the connecting-rods. In a fifty-hour test, the engine averaged 0·512 lb. of petrol per horse-power and 0·0024 lb. of oil per horse-power.

Asphaltic Road Paving.

Among the various kinds of paving used for public roads, although concrete is the material most generally used, are bituminous macadam, surface treatment with asphalt, and rock asphalt. Hot oil for surface treatment is used in some cases, but in general cold application is preferred. With the hot oil there is a tendency to build up thick mats or layers owing to the difficulty of controlling the oil, so as to form a thin layer. With such heavy mats the surface becomes wavy until the road is rough riding. Then the only remedy is to scarify and resurface the road. Asphaltic concrete is sometimes considered preferable to sheet asphalt, as there is greater stability in a well graded coarse aggregate bonded with asphaltic mortar. Slight changes in the composition do not affect the quality so much as in the case of sheet asphalt. A flush coat of asphalt cement seals the surface of the concrete and improves the wearing properties. Further, this coat is covered with a layer of stone chips, rolled in, which prevents the surface from being slippery in wet weather. In many cases, water-bound macadam is given a surface application of cold asphalt, with stone chips spread and rolled into it. For repairing breaks in the road pavement, cold-patch asphalt mixtures are used. For rock asphalt, laid in powdered form and rolled, a finishing machine may be used to smooth and level the surface in advance of the rolling.

Basic Open-hearth Furnace Work.

A recent paper by Mr. C. D. King, of the United States Steel Corporation, points out that advances in chemical, physical-chemical and metallurgical knowledge of open-hearth practice have not kept pace with those in design, decreased fuel consumption and increased length of furnace runs. In particular there is need for more knowledge of ingot yields. The difference between the weight of charge and the total weight of ingots and scrap produced is loss. But the yield in ingots varies considerably, and while some of the differences can be accounted for metallurgically, there remain others whose reasons are not apparent. There is now available a method of yield calculation which will disclose departures from normal good practice and can be applied to individual heats as well as for checking average conditons through extended periods. For any given charge and desired slag analysis or steel there is a definite yield, varying largely with scrap produced and miscellaneous losses. Because of the numerous losses possible in converting a metallic charge into steel ingots it is desirable to study all sources of loss, by means of carefully controlled heat tests. It does not follow that the best yield will give the lowest cost ingots. The yield does not necessarily determine the charge to be used, that being governed also by blast-furnace, open-hearth and market conditions. The physical factors involved in losses may be determined with desired accuracy, but the metallurgical phases require more comprehensive investigation of the physical chemistry of the metal and the slag.

A Presidential Chair.

IT will be recalled that at the last general meeting of the Institution of Mechanical Engineers the President, Mr. Daniel Adamson, gratefully accepted on behalf of the Council and Members a Presidential Chair presented by Sir John Aspinall. We are now able to give a picture

of this very handsome gift. The frame is in heavily carved oak, each of the main uprights being crowned by portrait busts, one of George and the other of Robert Stephenson. Beneath each bust is a small brass plate inscribed with a facsimile of the signature of the "sitter." In the centre of the back the old seal of the Institution, familiar to those who hold its certificates, is reproduced on a large scale, and on the back a brass plate records the name of the donor and the date. In congratulating the Institution on the possession of a gift which cannot fail to become more and more valuable as years go by and traditions and sentiments increase around it, we may venture to express a hope that the fine example set by Sir John Aspinall will inspire others. The Institution has, indeed, the nucleus of a good collection of portraits, some of which have been presented, but it is not rich in such things and it could well do with more portraits of famous engineers and pictures of famous events and works. Such possessions, as well as furniture and decorations, around which history may grow up as it has done in the Halls of the City Companies, would do much to add to the dignity of the Institution building and increase that affection which accompanies traditions.

B.E.S.A. Specifications.

WIRE ROPES FOR COLLIERIES.

IN continuance of the programme of work in its Colliery Section, the British Engineering Standards Association has just issued a British Standard Specification (B.S.S. No. 330) for Round Strand Steel Wire Ropes for Colliery Haulage Purposes. This specification, like the Colliery Winding Rope Specification (B.S.S. No. 300), contains clauses regulating the acceptance tests carried out in connection with the purchase of colliery haulage ropes. Three grades of material are specified, but, unlike the Winding Rope Specification, both basic and acid open-hearth steel are included. Analytical limits are included for all three grades of material. In addition to the usual general technical clauses, tensile and torsion tests are specified to be made both on the wire before it is made up into the rope and on wire taken from the completed rope. The more difficult question of flattened strand ropes is now being dealt with, and it is hoped that specifications will be available shortly for both winding and haulage ropes of flattened strand constructions.

PHOTOMETRIC INTEGRATORS.

THE British Engineering Standards Association has just issued a British Standard Specification for Photometric Integrators (No. 354, 1929). This specification deals with photometric integrators of either spherical or cubical shape. The integrator may be used for the measurement of the light output of tungsten filament electric lamps or for ascertaining the efficiency of translucent or dispersive reflector fittings, particulars for these fittings being dealt with in B.S. Specifications Nos. 324 and 232 respectively. The specification gives the necessary constructional details for integrators of 24in. and upwards in size, and it defines the requirements for the interior coating.

THE TESTING OF HYDRAULIC TURBINES.

A SPECIFICATION just issued is the latest addition to the list of British Standard Specifications for prime movers, which series includes specifications for steam turbines, reciprocating steam engines, and various types of internal-combustion engines. It differs from the preceding members of the series, however, in the fact that it relates entirely to the testing of the machine, and does not deal with the performance except in so far as the conduct of the test is concerned. The following points are dealt with in the specification :—Conditions of Head, Speed and Output for Acceptance Test ; Condition of Turbine during Test ; Speed Variation ; Power Output of Turbine ; Measurement of Net or Effective Head of Reaction Turbine, Pelton Wheel or Impulse Turbine ; Errors in Measurement ; Efficiency ; Measurement of Rate of Flow.

An Appendix deals with the information to be given with the inquiry or order. It is of interest to record that this Specification is based on, and is, to all intents and purposes, identical with the International Rules for the Testing of Hydraulic Turbines, published by the International Electrotechnical Commission.

Copies of these specifications may be obtained from the British Engineering Standards Association, Publications Department, 28, Victoria-street, London, S.W. 1, price 2s. 2d. each, post free.

SIXTY YEARS AGO.

VELOCIPEDES continued to attract our attention in our issue of April 16th, 1869. We have already noted in this paragraph the plans for the construction of a one-wheeled velocipede which a correspondent, "R. W. W.," of Dublin, had sent us and which we published. Our correspondent's design was very severely criticised by another correspondent in a succeeding issue, but the criticism evoked no reply from "R. W. W.," who no doubt soon discovered that his critic was right. The one-wheeled bicycle, however, continued to attract the interest of other inventors. In the issue we have mentioned we illustrated such a machine consisting of a single large wheel with a saddle for the rider placed over the centre. Propulsion was secured by means of a pair of treadles attached to cranks on the axle of the wheel. The inventor estimated that he would reach a speed of 25 miles an hour on this machine. The invention was apparently only in the design stage. It probably never progressed beyond that stage. If the inventor ever put it into practice we have no doubt that he ended by wishing that he had not done so. Another one-wheeled velocipede, the invention of Mr. R. Hemmings, of New Haven, Connecticut, was also illustrated. This machine consisted of two concentric hoops joined by short radial stays. The rider sat within them on a seat which was supported by means of three flanged wheels fitting on to the inner face of the inner hoop. On a stay joining the seat to the first of these grooved wheels and positioned directly in front of the seat was a barrel which the rider turned by hand, and from which two endless belts passed to pulleys on the axle of the second grooved wheel, which was of larger diameter than the first and third. The first wheel was at about 3 o'clock, the second at about 7, and the third at about 10 o'clock. The rider's feet were supported on stirrups, but propulsion was derived solely from the power of his arms by way of the barrel and endless belt. It was stated that the inventor's son had found it easy on the machine to keep pace with a good roadster. Two other machines were illustrated. They were power-driven velocipedes or steam carriages. One was an American invention. The second was the design of Mr. G. H. Goodman, of Southwark, London. Both were really steam tricycles. The English machine was equipped with a pair of reversing steam cylinders driving on to a crank shaft from which power was transmitted by endless belt to the rear—the two-wheeled—axle. The boiler was provided with a superheater, and was designed to contain sufficient heating surface to give two horse-power. The American machine had a boiler which was designed to carry a pressure of 200 lb., although the reassuring note was added that 25 lb. were said to be sufficient to give the machine a speed equal to that of a velocipede propelled by the feet.

THE Underground Railways have recently been experimenting on the District Railway with an improved form of high-speed electro-pneumatic brake, which effects simultaneous braking on all eight cars. With the existing braking system, the brakes cannot be fully applied to the wheels of the last coach for at least 4 seconds after they have been applied to the front coach. An order has been placed with a British firm for the equipment on one hundred coaches of the heaviest type.

Notes on High-speed Oil Engines.

THERE was a good attendance at the meeting of the Diesel Engine Users Association, held at Caxton House on Friday last, April 12th, when the first paper was read since the removal of the Association to its new headquarters at 307, Abbey House, Westminster, and the taking over of the joint honorary secretaryship, until recently held by Mr. Percy Still, by Engineer-Captain J. Hope Harrison, R.N., who holds office along with Mr. C. O. Milton. In the absence of the President, Mr. A. W. A. Chivers, who is on a voyage to South America, Mr. Geoffrey Porter, a past-President, took the chair, and called upon Mr. H. O. Farmer to read a paper entitled "Some Notes on High-speed Oil Engines." The author referred in his opening remarks to the increasing demand for the high-speed compression ignition oil engine, and its economical advantages in the wide field of application at present enjoyed by the low-compression carburetter engine. The problems connected with the development of the lightweight high-compression oil engine in order to meet the high standards of performance set up by the petrol engine, presented, he said, many difficulties. It was his purpose to deal with the four-stroke high-compression oil engine only on its thermo-dynamical side, comparing its performance with that of the petrol engine. The shape of the combustion chamber was considered and some typical designs were illustrated, after which fuel injection systems and forms of fuel valves were discussed at some length.

Comparative Oil Engine Particulars.

Slow-speed Engines.

Engine.	Cylinder bore inches.	Speed, r.p.m.	Piston speed. ft./minute.	B.M.E.P. lb./sq. in.	B.H.P./cub. inch of piston displacement.	B.H.P. per litre.	B.Th.U. used per sq. inch piston area per hour.	Remarks.
Vickers	30	110	825	76·5	·0000967	·65	—	—
Werkspoor	28·75	95	783	71·2	·0000875	·505	3,120	Air injection
Werkspoor	22·05	125	820	72	·000095	·725	3,450	Air injection
Hick Hargreaves	18	175	760	91	·000115	1·23	3,820	—
Ruston	16	250	920	68	·000086	1·31	3,550	—
Belliss and Morcom	15·5	350	995	70·5	·000125	2·67	3,120	Air injection
Crossley	11	250	835	72·4	·000091	1·72	3,380	—
Hesselman	9·85	300	728	75·6	·00014	2·56	2,960	—
High-speed Engines.								
Ingersoll-Rand	10	600	1,200	70	·0000885	3·23	4,980	Locomotive
Beardmore	8·25	1,000	2,000	64·2	·0000812	4·95	6,450	Locomotive
Ricardo	7·5	900	1,800	83	·000104	5·73	8,050	—
Atlas	6·5	650	920	81	·000102	4·05	—	Excavator
Cummins	5·75	685	970	91·6	·000115	4·85	—	Excavator
Maybach	5·5	1,200	1,420	91	·000115	8·4	8,570	Air injection
Benz	5·32	800	1,050	84·5	·000081	5·2	5,670	Tractor
—	4·75	1,000	1,080	90	·000113	6·9	6,020	Lorry
Deutz	4·53	1,000	1,120	87	·00011	6·7	6,300	—
Saurer	4·33	1,400	1,380	78·5	·000099	8·5	7,720	Lorry
Acro	3·94	1,500	1,380	71	·0000895	8·2	5,720	Lorry
Dorner	2·7	1,400	910	57	·000072	6·1	4,340	—
Petrol Engines.								
Bristol Jupiter	5·75	2,200	2,750	103	·00013	18	—	Air-cooled aero
Thornycroft	5·75	1,550	1,810	88	·00011	11	15,700	Marine
Rolls-Royce	5	2,250	2,060	146	·000185	26	19,500	Aero
Karrier	3·13	2,200	2,170	91	·0002	15	—	Omnibus
Riley	2·375	4,000	2,500	82	·000105	25	18,700	Car

The author put forward the suggestion that in order to obtain the highest efficiency constant volume combustion should be aimed at. With a compression ratio of 14 to 1, and a brake mean pressure of 80 lb. per square inch, the maximum gas pressure worked out at 1200 lb. per square inch, which would not be permissible on mechanical grounds, lower pressures being desirable. In order to obtain a smooth running engine, it was desirable, he thought, that the rate of pressure rise should not exceed some 40 lb. per square inch per degree of crank angle, and diagrams for both pressure and temperature rises per degree of crank angle were given. The following comparison of a 40 B.H.P. high-compression oil engine and a petrol engine of the same output was put forward :—

	Petrol Engine.	Oil Engine.
Speed (r.p.m.)	1000	250.
Engine weight	1300 lb.	8000 lb.
Fly-wheel weight	160 lb.	5000 lb.
First cost	£4 per H.P.	£10 per H.P.
Fuel consumption	·45 lb./B.H.P./hour	·45 lb./B.H.P./hour

In a table, reproduced above, the author gathered from published tests comparative figures for four-stroke single-acting oil engines of the slow-speed and high-speed types and petrol engines.

The remaining part of the paper was devoted to an illustrated description of a 45 B.H.P. four-cylinder, high-compression oil engine designed by Ricardo and Co., Ltd., for a 4 to 5-ton lorry chassis. The engine has a cylinder bore of 4·75in., with a stroke of 6·5in., and its designed speed is 1000 r.p.m. Bench trial results were given with the engine working on a standard light Diesel fuel of 0·89 sp. gr. During these tests the maximum gas pressures were limited to 800 lb. under any conditions, and under normal road conditions these pressures would not exceed 750 lb. When fitted to a 4 to 5-ton commercial chassis, the engine was found easy to handle, and a good puller, with the result that less gear changing had to be done. The exhaust when running normally was quite clear, but when starting from cold or when idling there was slightly more smoke than was given by a petrol engine.

IT is proposed to construct a long-distance telephone line between the Kwangtung and Kwangsi Provinces of China. The three lines to be first started are the Sikiang-Wuchow, Yinlien-Nanning, and Lienshan-Kweitao Lines which will be extended to link up with other cities from time to time. A survey of the lines is now being made by engineers.

South African Engineering Notes.

Proposed Central Garage Scheme.

A MOVEMENT is at present on foot, in Durban, to form a company for the purpose of attempting to solve the parking problem, which grows daily more pressing, by the establishment, at an estimated cost of £51,000, of an elaborate centrally-situated five-storied motorists' club and garage. The building is designed to accommodate up to 1000 cars on four floors, with club-rooms, lounges, smoking and card-rooms, a concert hall with stage, a tea-room, a parcel receiving depôt, balconies 20ft. wide, a spray fountain rockery and fish pond on the fifth floor. The ground floor will be occupied by the lift entrance, a bioscope hall, a space for washing cars, &c. Cars will be driven from the road directly on to a loading platform, and into high-speed elevators, in which they will be conveyed to the required floor, where gyrating steel arms will roll them into fireproof stalls, the time occupied in the whole operation being less than a minute. A control board at the entrance to each lift will indicate the vacant stalls, and the act of withdrawing a key controlling any particular stall from its place on the board will automatically set the storage table travelling towards the shaft of the lift containing the car. The owner retains the key until he requires his car again, when, on inserting the key in the control board, the reverse operation takes place, and his car is returned to him within a minute, guaranteed free from scratches or other damage. The whole scheme is somewhat fantastic, but should it prove to be financially sound, it is considered locally that it will go far to relieve the congestion which is at present being experienced.

£1,000,000,000 Worth of Gold.

During 1928 the Transvaal increased its production of gold by over one million pounds sterling in value, as compared with 1927, which had eclipsed all previous "best" records. The output from all Transvaal gold mines amounted to 10,358,596 fine ounces, valued at £43,571,140. This is an advance on the previous year's figures of 227,966 oz. and £1,117,953 in value. Since the commencement of the fields, the Transvaal has produced no less than 229,936,205 oz. of gold, representing at standard value a revenue of £972,454,600, or, if the premium received during a part of the post-war period be added, the grand total passes the thousand millions.

Big Manganese Agreement.

The negotiations which had been going on for a long time with regard to the manganese deposits in the Postmasburg district of the Cape Province have at length in one instance been brought to a successful conclusion. On February 22nd the Minister of Railways announced that an agreement had been concluded between the Union Government and the British-Swiss International Corporation of London, by which the Railway Administration will build and operate a railway to serve the manganese deposits at Postmasburg. The London Company is to provide the capital upon which Government will pay 4½ per cent., the capital sum being returnable to the company at the end of ten years. The company has, in addition, to deposit securities to the value of £100,000 to cover the guarantees and obligations undertaken, and has also agreed to pay any loss in working the railways. It furthermore has undertaken to forward by rail manganese ore to the extent of 200,000 tons in the first year after the line is open for traffic, and 350,000 tons per annum for each of the following nine years. Any quantity short of that tonnage is to be paid for by the company at the rate of 2s. per ton.

The agreement also provides that in the event of satisfactory arrangements being made with the Electricity Supply Commission, and subject to an adequate water supply being available, the company will erect a smelter for converting the manganese into ferro-manganese, the works to be capable of treating from 50,000 tons to 100,000 tons per annum, according to circumstances. The company is authorised to assign the contract to a company, with a nominal capital of not less than £800,000 sterling, to be registered within the Union within six months from the date of Parliamentary sanction for the construction of the railway. Other manganese producers using the railway will have to pay a proportionate share of the cost and assume a proportionate share of the obligations and duties of the company under the guarantees. The company which it is proposed to form to work the manganese deposits will be called the Manganese Corporation of South Africa, Ltd., and will be registered at once. The capital is £1,000,000.

Vast quantities of the ores with which it is proposed to deal have already been quarried, and its quality can be gauged from the following four analyses which are said to be typical of very many that have been made :—

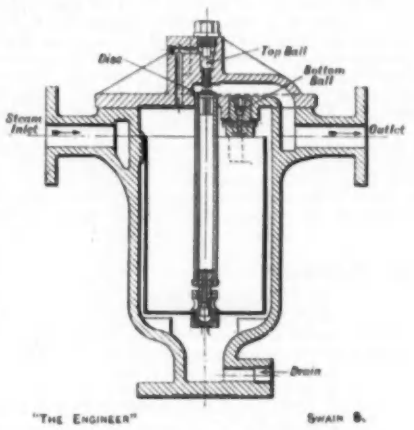
Sample from—	Metallic manganese. Per cent.	Metallic iron. Per cent.
Beeshoek No. 6 Cut, 25ft. level	56·0	4·98
Beeshoek Colvert Cut, 43ft. level	56·0	4·98
Laces Goat Cut Doornfontein, grab sample	55·5	6·78
Paling No. 2 Cut, grab sample	54·0	4·56

A New Steam Trap.

A NEW type of steam trap which is being manufactured by Holden and Brooke, Ltd., of Sirius Works, West Gorton, Manchester, is illustrated by the drawing below. Its peculiarity lies in the fact that provision is made for the automatic discharge of any air which may collect in the body of the trap to the detriment of its working.

As will be seen from the drawing the trap is of the orthodox bucket type. That is to say, it relies for its action on the flooding of a bucket, in which the condensate collects. The bucket then sinks and opens a valve at the bottom of a discharge tube, so that the steam pressure can expel the water. The bucket then rises again and closes the valve to prevent the escape of steam.

There is, of course, always a tendency for air to collect in the upper part of the trap, and it is usual to provide a pet cock for its discharge, but this arrangement requires periodic attention. With the Autovent trap, however, no attendance is required, as the air is discharged automatically through two ball valves. One of these balls serves to release the air on starting up, and the other during normal working. The lower ball has two seatings, one above and the other below, and it is so proportioned that at a pressure of about 5 lb. per square inch it will float between these two seats. Then, during the process of gradually turning on steam any accumulated air is expelled through this valve, but as soon as the pressure rises the ball is held against its upper seating and any further escape of steam is prevented.



AUTOVENT STEAM TRAP

In order to provide for the discharge of air which may come in with the condensate during normal working, a second ball valve is arranged in the top of the casing. This valve, it will be seen, is normally closed by the pressure of the steam above. Immediately below the ball there is a disc, seated on the top of the central discharge tube of the trap. A stem on this disc extends upwards so as nearly to touch the ball. When the trap discharges the disc rises and lifts the ball off its seating, so that there is a free way for any air in the top of the casing to blow through to the outlet; but immediately the discharge ceases the ball is pressed back on to its seating by the steam pressure.

It will be noticed that the trap has the merit that all the working parts are easily accessible without it being necessary to disconnect the inlet and outlet branches.

EDUCATION IN INDUSTRY.—The programme for the annual Conference of the Association for Education in Industry and Commerce, which takes place in London on July 2nd and 3rd, has now been settled in outline. The outgoing President, Lord Riddell, will install as his successor Sir Max Bonn, K.B.E., a partner in the well-known firm of bankers, Messrs. Bonn and Co., and chairman of the London Advisory Council for Juvenile Employment. The presidential address will be delivered on July 2nd, and will be followed by a luncheon given by the new President at the Savoy Hotel, at which leaders in industry and commerce are expected to be present. On the second day the Conference will meet at the Polytechnic, Regent-street, when Mr. Frank Pick, managing director of the Underground group of companies, will read a paper on the "Training of Employees," and Mr. Harold Rostron, of the Tootal Broadhurst Lee Company, will present a report on Training for Higher Positions in Commerce. The Conference delegates will pay two visits to London works. On the first day they will be the guests of the United Glass Bottle Manufacturers, Ltd., of which firm Sir Max Bonn is deputy chairman, and on the second afternoon, at the invitation of Lord Ashfield and his fellow-directors, they will study the training given to employees at the works of the Underground group.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

General Situation.

THE iron and steel and engineering industries of the Midlands and Staffordshire retain the note of optimism which has characterised them for the last month or two. Last week's quarterly meeting in Birmingham proved uneventful, and while values were strong there was no further price appreciation of any significance. Business done was on the small side, but hopes of an improved volume of trade were expressed in nearly all departments. It was generally agreed that the first quarter of the year has brought a general improvement in the basic industries of this district, and it is confidently anticipated that progress will continue to be made during the current quarter.

A Hopeful Budget.

The Budget had a quiet reception in Birmingham and the Midlands, but it was considered in many industrial circles as "hopeful." Satisfaction was expressed that on the basis of his estimate Mr. Churchill looks forward to a period of improving trade. The Chancellor should be in as good a position as anyone to judge the tendency of trade in this country at the present time. He has the support in his theory of Sir Gilbert Vyle, who on Monday last stated that things in general, from the point of view of industry and commerce, were distinctly better to-day than they had been for many years past. He expressed the hope that, having turned the corner, they would now go right forward.

Warwickshire Pits and Production Returns.

The failure of some of the Warwickshire pits to furnish the Wages Board with returns of production for January and February of this year has created considerable dissatisfaction in this coalfield, and there is trepidation lest industrial peace should be disturbed. The Warwickshire Miners' Association has reported through its secretary, Mr. William Johnson, of Bedworth, that there is a growing feeling of discontent, arising from the fact that the men do not know what is the proper wage total to which they are entitled. In the absence of the returns, the Wages Board cannot compute the amount due to the men under the ascertainment now due, and it is pointed out that the present position resolves itself into a delay in the automatic determination of the wage totals, which has been the principle of agreements between masters and men in the mining industry since the strike of 1921. Present indications are that the Wages Board will be called together, under the independent chairmanship of Sir Walter Lawrence, to see what can be done in the matter. The problem has been considered by the owners' association, but up to the time of writing no way out of the difficulty has been forthcoming. The owners' chief difficulty seems to be reconciling the position of pits known to be uneconomic at the moment with those showing better returns. Further, the owners claim that the completion of the returns at present not made up would prejudicially affect the ultimate amount due to the men for that reason. It is much to be hoped that any serious crisis will be avoided.

Birmingham's Weak Bridges.

Mr. H. E. Parkes, of Birmingham, quoted some remarkable figures during a discussion at the annual meeting of the Association of British Chambers of Commerce on weak railway and canal bridges. He asserted that, in the Birmingham district, they had 254 bridges which still required attention, and, if they continued at the present rate of progress, it would taken 170 years to complete the strengthening of the bridges in that area alone! In the Birmingham and Staffordshire district they were strengthening at a rate of only one and a half bridges a year. The position was serious, for if bridges remained closed to heavy traffic industries would be brought to a standstill.

Rolling Stock Contracts.

Midland rolling stock establishments continue to secure welcome new orders, and are enabled to keep the shops regularly employed. The latest orders received are from the London and North-Eastern Railway Company, and are for three quadruple unit trains, two of which are to be made by the Birmingham Railway Carriage and Wagon Company, Ltd., of Smethwick, and one by the Metropolitan Cammel Carriage, Wagon and Finance Company, Ltd., of Saltley.

Road Sleeping Coaches.

Wolverhampton is playing an important part in the development of luxury road transport, for there the engines and chassis of the immense new double-decked, six-wheeled sleeping coaches which are now making their appearance on the main traffic routes of the kingdom are being produced. The first of these double-deck road sleeping coaches has just been manufactured by Guy Motors, Fallings Park, Wolverhampton, for Land Liners, Ltd., which is inaugurating a day and night service between London and Manchester. The chassis is one of the six-wheeled type and accommodates forty-four passengers on the day service and twenty-one when the sleeping berths are in use during the night journeys. This is in addition to the driver and steward. Sleeping accommodation comprises four four-berth cabins, two double-berth cabins, and a single-berth compartment. There is plenty of luggage accommodation, lavatory with hot and cold water, and a kitchen.

Wednesbury Steel Works Fire.

Damage estimated at some £10,000 was caused by a fire which broke out on Saturday last at the works of F. H. Lloyd and Co., Ltd., James Bridge Steel Works, Wednesbury. The fire started in the pattern shop, which the fire brigade was unable to save. It did, however, prevent the flames from spreading to adjoining shops and stores. Many valuable patterns and workmen's tools and much machinery were destroyed.

Imports and Exports.

Midland industrialists derive some satisfaction from the fact that, although in March iron and steel exports were down by £886,462, the total value last month being £5,346,443 against £6,232,905 a year ago, for the first quarter of the year the total value of £17,337,660 was an improvement of no less than £690,000 on last year. Moreover, the imports of iron and steel continue to decline, leading to the belief that native producers are securing an increased proportion of the volume of orders given out, for consumptive demand can hardly be said to have fallen away last month. The quantity of iron and steel imported last month was 182,107 tons, valued at £1,672,414, compared with 271,526 tons and £2,258,847 in the corresponding month of last year. For the year to date the quantity was 586,409 tons, valued at £5,236,544, compared with 842,365 tons and £6,815,791 in the preceding year. It is worthy of recording also that there is on the three months' comparison an increase of just over £2,000,000 in exports of goods under the vehicles group.

Production Figures.

The trend of business in the raw iron industry is shown by the fact that the number of furnaces in blast at the end of March was 145, a net increase of five since the beginning of the month, seven furnaces having been blown in and two having ceased operation. The output figures, though slightly lower than in March twelve months ago, were an advance on those of February, and are considered by Midland smelters to be quite satisfactory. The production last month amounted to 590,500 tons, compared with 519,600 tons in February and 592,600 tons in March, 1928. The daily rate in March was thus 19,048 tons, compared with 18,557 tons in February. The output, it is interesting to note, included 189,300 tons of hematite, 251,200 tons of basic, 108,300 tons of foundry, and 21,300 tons of forge pig iron. The output of steel continues to grow, and give cause for satisfaction. Production of steel ingots and castings in March amounted to 859,900 tons, compared with 774,900 tons in February and 793,300 tons in March, 1928.

Steel.

Business flows steadily, if unevenly, in the steel trade, and with prices unchanged a considerable advance in demand for finished material is expected to develop. Constructional engineers in the Midlands are at date not too well supplied with orders, but some contracts are expected to develop shortly, calling for large tonnages of steel. There is a better call for plates and mills are moderately engaged. Angles and joists are quoted £7 17s. 6d.; tees, £8 17s. 6d.; ship, bridge and tank plates, £8 12s. 6d.; boiler plates, £9 15s. A brisker inquiry for the latter has resulted in at least one firm asking enhanced prices. As much as £10 5s. is reported to have been quoted, but it is difficult to trace business as having passed at this figure. In the semi-finished department native steel works continue to improve their position, despite the fact that there has been some reappearance of German billets on this market. France and Belgium, however, still fail to display signs of interest in local business. Continental prices remain firm and the difference between them and native makers' prices is insufficient to induce users to place orders abroad. Midland producers of small steel bars continue to ask round about £8 5s. for their product while billet makers ask £6 10s. for 2¼in. and over. South Wales makers of billets are stated to be prepared to do business at at least half-a-crown below this figure.

Pig Iron.

The pig iron market is quiet, buying for the most part being limited to small parcels. There are indications, however, of an increase in consumptive demand. While foundries in the Birmingham area have not been calling for very much more pig iron there has been a reawakening at the forges. Some of the puddling furnaces which have been standing idle so long are being recommissioned, and there are other indications of a more hopeful spirit in the wrought iron branch. The shortage of steel scrap has also accentuated the demand for pig iron. At last week's quarterly meeting some inquiries were in circulation relating to substantial pig iron contracts, but producers were inclined to view them as merely price-testing inquiries. Midland producers and consumers of forge and foundry pig iron are still in strong opposition on the question of prices. Northamptonshire and Derbyshire makers, however, are very firm in their quotations of £3 5s. and £3 9s., and £3 8s. 6d. and £3 12s. 6d. respectively, delivered at Black Country stations. The scarcity of coke in the Midlands has been relieved a good deal, though supply is not adequate for the needs of Midland furnaces. The increased rate at which basic pig is being consumed denotes great activity in some branches of the steel trade. Steps are being taken to increase production as more coke becomes available.

Finished Iron.

The improvement in the Staffordshire iron trade is maintained, and the outlook gives ground for satisfaction. This material is becoming more popular with engineers, while shipbuilding activity is responsible for an increase in the call for iron for chain and cable making. The recovery in trade and the fact that costs of production have risen steadily had prepared users for a rise in prices. Makers of marked bars, however, considered it wise not to jeopardise the improvement by advancing the basic price of their products, and this, notwithstanding the fact that Crown bar prices have appreciated of late. There is still, however, a difference of £2 or more between the selling figure of marked and Crown iron, and the rise in the price of the latter has not led to any encouraging business. Best bars stand at £12 per ton and Crown bars are quoted £9 15s. to £10. It is possible to buy Crown iron below this price in other districts. Business in nut and bolt and fencing bars is extremely poor. Local manufacturers are either using Belgian No. 3 iron, procurable at £7 5s. delivered South Staffordshire, or are utilising steel. Wrought iron tube strip mills are running regularly, and there are prospects of continued operations for some time to come in this branch. The new selling figure of £10 17s. 6d. is being conceded by users who in some instances are glad to get deliveries even at slightly higher rates.

Galvanised Sheets.

There is an enlivenment of demand for galvanised sheets and market conditions are generally quiet. Values are substantially unchanged, there being insufficient business passing to prove a real test as to prices. Quotations for 24 gauge corrugated sheets vary from £13 7s. 6d. to £13 10s. Mills in this area are still able to keep plant in operation, but new orders will soon be urgently wanted. Black sheets for the motor manufacturers are in steady request, but orders, though regular, are small.

Tin-plate.

There has been increased activity of late in the tin-plate trade of the Midlands. The revival in South Wales has, of course, been promoted by improving sales overseas. Millowners who attended the Birmingham quarterly meeting last week required a month or two for delivery in most cases. One stated that he had sold his output up to August. Business rules at 3d. to 6d. premium on the basis of 18s. for primes, wasters being about 1s. less.

Scrap.

The increased consumption of steel scrap has brought about a shortage of this material, and prices are high. Supplies are so scarce that sellers are encouraged to stand out for £4 per ton delivered South Wales. The scarcity is due partly to increased consumption at English steel works. But the make of basic iron is not sufficient for the present needs, and if the production of basic could be increased, the scarcity of steel scrap would probably be relieved.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Manchester–Altrincham Electrification.

MARKED progress is being made in the work of electrifying the old Manchester South Junction and Altrincham line—a distance of nearly nine miles—by the London, Midland and Scottish, and the London and North-Eastern Railways. An official announcement this week states that a beginning will be made this month on the erection of the overhead electrical equipment to work on 1500 volts direct current. The rolling stock will consist of six-car trains of the compartment type which will be divided into three-car trains, each six-car train having a seating capacity for 536 passengers. An electric train repair and inspection depôt is to be established at Altrincham and two new stations constructed, one at Dane-road and the other at Navigation Crossing, North Altrincham, the Lancashire Cricket Ground Station at Old Trafford being permanently opened. The companies state that increased and accelerated services will be provided when electrical traction commences, representing a 50 per cent. increase in train mileage over the augmented steam service. The Manchester–Bury and Liverpool–Southport lines are other examples of railway electrification in Lancashire on the London, Midland and Scottish system. Both of them, however, are working on the third-rail principle, the first at 1200 volts and the second at 600.

Between Two Cities.

The opening of the new "half-mile" platform between Victoria and Exchange Stations, Manchester, on Tuesday of this week—the one on the Manchester side of the river Irwell and the other on the Salford side—lacked neither colour nor ceremony when Miss Ena Best, the "Railway Queen," cut the tape. The work of constructing what is said to be the longest railway platform in the country has been in progress for about three years, and has involved several engineering feats of no small magnitude. The existing bridge crossing the Irwell has had to be widened and strengthened to the extent of 30ft., and in the work it is estimated that the consumption of concrete was 2320 cubic yards. One of the problems was the "slewing" of a parapet girder 142ft. long and weighing 85 tons, a distance of 32ft. A steel lattice girder weighing about 100 tons was constructed on the site. The exact length of the platform, which will accommodate three trains at once, is 2238ft. The installation of the new electrically-operated signalling system, which has been referred to in this column on several occasions during the past month or so, formed part of the work.

Short-Time in the Railway Shops.

With regard to the short-time working notices in the railway engineering shops which operate as from the end of this week, it is reported that at the Crewe works of the London, Midland and Scottish Company, there is every likelihood of one or two of the larger departments continuing normal working. An order for several thousand tons of steel girders to be used in the construction of the company's Holyhead cattle docks is expected to keep the forge department busy for at least a year.

Locomotives for the East.

Twenty-three 60-ton locomotives manufactured locally for export to Madras, Bombay and Port Sudan were shipped on board the "Belray" at Manchester Docks during the past week. The vessel has been specially constructed to carry locomotives and other railway equipment, and altogether, below and on deck, has a carrying capacity of thirty-two locomotives. On the present occasion she is proceeding to Middlesbrough to complete her

cargo before going East. This is not the first visit of the "Belray" to Manchester, and shipments by the same vessel have, I believe, been made from Birkenhead. I had a good view of her last Saturday morning lying in the Ship Canal opposite the British Oil and Cake Mill's Trafford Park Works, when about eight locomotives were still waiting on the dock side to be taken aboard. This task is performed by powerful derricks, one of which has a load limit of about 100 tons. The "Belray" is Norwegian owned, and is a vessel of 4200 tons.

A Question of Division.

The limit of parochialism threatened to be reached at the last meeting of the Manchester City Council, when a recommendation of the Gas Committee for the acceptance of a tender of a Liverpool engineering firm for the supply of gas meters at a contract price of £41,600 came under consideration. An amendment was submitted, on the grounds of local employment, urging that a tender which was £1600 higher—that of a Manchester firm—should be accepted. Both this amendment and a further suggestion that the contract should be divided between the two firms were defeated.

Textile Machinists' Smaller Profits.

The accounts for the twelve months ending March 31st of Howard and Bullough, Ltd., textile machinery manufacturers, of Accrington, show a remarkable fall in the net profits compared with the previous year, owing probably in no small degree to the impoverishment of a good many Lancashire cotton concerns. The profits amount only to £71,447, against £139,143, and after paying debenture interest and preference dividend, a distribution of 8¾ per cent. is made to the ordinary shareholders, against 10 per cent. in the previous year, and only £3093 is carried forward compared with £66,021.

Non-ferrous Metals.

Apart from the more purely speculative operations—and they are still on a considerable scale—trade buying of the non-ferrous metals is likely to continue on cautious lines, until something approaching reasonable stability is reached. So far as copper is concerned, this stage, judging from the course of events during the past week, is still distant, for the movements of the metal have been erratic in the extreme. After the serious collapse of the market referred to in this column a week ago, prices effected some recovery, but the opening days of the present week have witnessed a repetition of the bearish movement, and at the time of writing values are quite £4 to £5 10s. a ton lower on balance, according to position. There has been a fair amount of buying going on in the tin section, but it also has been for the most part speculative in character, and quotations have been further depressed to the extent of over £3 a ton. For the time being, lead appears to be reasonably settled, and fluctuations have been on a limited scale, no more than 5s. to 10s. dividing current values from those quoted here a week ago. A fair weight of business has been done in this section of the market. Spelter has been in moderate request, with prices about 5s. lower on the week.

Iron and Steel.

Up to the present there has been little sign of expansion in the iron and steel markets locally. New business in pig iron is very restricted, although delivery specifications against old contracts continue to move fairly satisfactorily. On balance quotations are pretty well unchanged though decidedly firm all round. For delivery to Manchester users, Staffordshire No. 3 iron is quoted at 73s. 6d.; Derbyshire makes at 71s.; Middlesbrough at about 81s.; Scottish at 90s.; and hematite iron at up to 87s. per ton all delivered. Inquiry for bar iron is still rather slow, with Lancashire Crown bars at £10 10s. per ton, and seconds at £10. Apart from a slight spurt in forward buying of general plates on the strength of a possible advance, the movement of steel generally has been of moderate dimensions, with, at the moment, little quotable change in individual prices. Neither finished nor semi-finished steel materials of continental origin are active, but quotations are well maintained, and here and there slight advances have taken place within the last few days, heavy sheet bars being on offer for delivery to Lancashire works at about £6 2s. 6d. per ton; billets at £6 1s. to £6 3s. 6d.; wire rods at £7 2s. 6d.; angles at £6 15s.; joists at £7 5s.; steel bars at £7 2s. 6d. to £7 4s.; and Siemens plates at about £7 15s. per ton.

Barrow-in-Furness.

Hematite.

There is no change to report as to business in hematite pig iron. Makers are practically clearing their output, and the prospects are good, taking everything into consideration. The stiffening of the price has not been welcome, but makers were bound to demand a price which would allow them a margin. Buyers are satisfying their immediate needs and are ordering to a certain extent to cover future requirements, but they are not fully committing themselves, evidently owing to present ruling prices. The steel departments continue to take a fair amount of iron, and that is an important factor. The possibility of there being a further increase in production is mooted, but makers will have to be fully assured of future business before they increase the present number of furnaces in blast, which is eleven. Special qualities of iron are in good demand, and the Continent and America are customers. Iron ore remains about the same as regards demand. The steel trade is moderate but the works continue on railway material, and there are contracts held to keep them going for some time yet. Hoops are in steady demand, and the mills are assured of a steady run.

SHEFFIELD.

(From our own Correspondent.)

Steel Trade Position.

The improvement which was noticeable in the steel and allied trades after the Easter stoppage is not continuing, and the faint promise of a revival is not being fulfilled. Several departments are fairly busy, but there are too many dull spots for the position to be satisfactory. Business is best in the basic steel branches, and there is also a good demand for special lines. The call for acid steel is still poor, although there is a slight tendency towards improvement, and there is very little business being done in ordinary commercial steels. Railway work is still scarce and rolling mills and forges are by no means fully employed, but there is an improvement in the best tool steel trade. There has been a substantial increase in the unemployment figures locally, but most of it is gradually being reabsorbed.

Important Contracts.

It is stated that British industry has received an order valued at between £50,000 and £60,000 from the Soviet Government, representatives of whom, including the President of the Russian Railway Commission, have just paid a visit to this country. Sir Herbert Lawrence, chairman of Vickers-Armstrongs, Ltd., has announced that negotiations have just been concluded with the Soviet Government for the supply of railway wheel tires and axles to the Russian Government Railways by his firm. There is also a report that Major Green, the representative of Vickers-Armstrongs who went with the British trade delegation to Russia, is negotiating with the Soviet Government for the supply of aeroplane materials. The London and North-Eastern Railway has placed the following contracts for new trains to be used in the London suburban district:—Clayton Wagons, Ltd., two quintuple unit suburban trains; Craven's Railway Carriage and Wagon Company, one quadruple unit suburban train; Metropolitan-Cammell Carriage, Wagon and Finance Company, Ltd., one quadruple unit suburban train. In connection with the erection of a new super-power electrical generating station for the Sheffield Corporation, the English Electric Company, Ltd., is to supply a turbo-alternator and condensing plant at a cost of £94,413. It is stated that the company will manufacture the turbine at its Rugby works, and the alternator at Preston, Lancashire. The unit will have an output of 25,000 kilowatts, and will run at 3000 revolutions per minute. It will be supplied complete with condensing plant. Thos. W. Ward, Ltd., of Sheffield, have sold the spring manufacturing shops at the High Yard Works of J. Spencer and Sons, Newburn-on-Tyne, together with the necessary plant and equipment, to a firm which is to recommence manufacturing the springs which Spencers previously supplied to home and foreign railways, &c. The rest of the works is being dismantled.

Continental Steel Castings.

The question of the comparative purity of British and continental steel is of great interest to the foundry and engineering industry of this country, and an important point has been raised by a letter from the head of a large steel firm to Edgar Allen and Co., of Sheffield. This letter suggests that while British steel founders are compelled to adhere strictly to British standard specifications, continental makers are allowed to evade them. As a result of an investigation of the chemical properties of a number of imported steel castings, which was conducted by the writer's firm, it was found that as regards some of them the sulphur and phosphorus contents were extremely high compared with British standards. Mr. W. E. Wells, a director of Edgar Allen and Co., in a reply to this letter, states that the experience of the correspondent conformed with that of his own firm. He mentions an instance of foreign castings supplied to a Dominion railway, which an analysis showed to have sulphur and phosphorus contents far in excess of the maximum allowed by the British standard specifications to which they had been made. Moreover, sections which should have been forged had actually been cast to size, and all the articles were unsound at a vital part, breaking rapidly. Mr. Wells adds that it seems grossly unfair that material offered against the British standard specification should not conform to it.

Important Reorganisations.

Considerable interest has been aroused by recent announcements in regard to important industrial concerns. The board of the United Steel Companies, Ltd., is recommending the acceptance of an offer by the Austin Friar Trust, made on behalf of itself and others interested in the question of the rationalisation of the iron and steel industries, in regard to the rearrangement of the finances of the companies and the provision of additional funds. It was in March, 1928, that this huge concern, based on Steel, Peech and Tozers, was formed, and it has big interests in Sheffield and district, North Lincolnshire, Cumberland, &c., with a capital of over £9,000,000. Reconstruction in some form has been expected for some time. Another important announcement was concerned with the firm of Darwins, Ltd., of Sheffield, which went into the hands of the liquidator in July, 1927, after making a bold attempt to capture a big portion of the safety razor industry. It is now reported that during the period from July, 1927, to the end of November last year a net profit of £58,147 was made, and since that date improved progress has been made.

Sheffield Works Purchased.

The works and old-established business of John Henry Andrew and Co., Ltd., Toledo Steel Works, Neepsend, Sheffield, have been purchased, and a limited company is being registered to carry on the concern under a new title. The works cover a wide range of steel products, and are among the largest in Sheffield. They include an open-hearth steel plant and a wire rod rolling mill.

Cutlery and Plate Trades.

The demand for hollow-ware is very poor. Retailers are complaining of a declining demand on the part of the general public for plate, and if it were not for an increasing call from hotels, restaurants and liners, the trade would be in a very poor way indeed. Some firms were hard hit by the recent sharp rise in the cost of nickel silver used in the electro-plate trade, but prices have dropped again now to a level which is almost normal. There has been no improvement in the cutlery trade, and a few firms are fully employed. Exports of British files and rasps last year, it is now learned, amounted to £302,000, which was slightly below the figures of 1927. The export trade in saws last year amounted to £327,162, which was £72,000 less than in 1926 and £25,000 less than in 1927.

Water and Drainage Schemes.

The Welland Drainage Board at Spalding has been considering a scheme for outfall improvement and the extension of the training walls of the river Welland seawards, at an estimated cost of £190,000. The Northern Channel scheme is to be adhered to, and the board is authorised to enter into an agreement with the Boston Harbour Commissioners to the effect that if, during the construction of the works by the Board, the operations cause by silting an obstruction to navigation in any part of the channel under the control of the Harbour Trust, the Drainage Board will pay reasonable expenses incurred in dredging. The Blackwell Rural District Council and the Warsop Urban District Council have in hand a joint water scheme which it is estimated will cost £165,000. It is stated that the remaining obstacles in the path of the scheme for the building of a new fish dock at Grimsby have been removed, and it is hoped that the work will be begun during the summer.

Colliery Output Record.

The Brodsworth Colliery, near Doncaster, claims to have established a world's record for one day's output of coal, having "turned" 6777 tons in one day and 30,340 tons in a week.

NORTH OF ENGLAND.

(From our own Correspondent.)

Cleveland Mines Reopening.

The industrial outlook in the Cleveland ore mining area is rapidly improving, and two more mines are to be reopened shortly. One of them is the Grinkle Mine, which, except for a short period of a few months, has been idle since 1921. The mine will be restarted on May 6th, and when operations reach their full extent over 300 men will be needed. The opening of this mine follows upon the decision of Palmer's Shipbuilding and Iron Company, Ltd., to restart its two blast-furnaces at Jarrow-on-Tyne, probably in a fortnight's time, which will mean the provision of work for approximately 1000 ironworkers. One of the furnaces will be engaged on the production of Cleveland iron and the other on hematite. After being closed for nearly two years, Bolckow, Vaughan and Company's Skelton Mine will be reopened on Monday, April 29th. Before it closed down about 300 men were employed and it is expected that a similar number will be required when work is resumed. One of the serious effects of the long depression in the industry is a diminution in the available number of skilled workers, and mine managers may experience some difficulty in getting their requirements fulfilled. Several of the mines have been closed so long that many boys have grown into manhood without opportunity for training in the ironstone industry, while at the same time many miners, elderly when the depression settled in the district, have grown too old to be any longer employable. Many skilled men, too, have left the district to find work elsewhere. Thus, while there are large numbers of unemployed in the area, the number of men practised in the work of ore mining is limited. The prospect of securing work in their old occupation may, however, induce many miners who left the district to return.

Cleveland Iron Trade.

The stringent situation in the Cleveland pig iron trade is causing much uneasiness. Saleable stocks are very small, and output is inadequate to needs. Preparations are in progress for some enlargement of production, but there seems little prospect of the make being sufficiently increased to cope with requirements. Home consumers are understood to have further substantial orders to distribute, and there are signs of much improvement in export business. Some overseas inquiries are from districts which were once supplied mainly from Cleveland, but which for some time have been using the products of continental competitors. Prices are very firm, No. 1 Cleveland foundry iron being 71s.; No. 3 G.M.B., 68s. 6d.; No. 4 foundry, 67s. 6d.; and No. 4 forge, 67s.

Hematite Pig Iron.

The demand for East Coast hematite pig iron is still expanding, and enlargement of production by the blowing in of a furnace at Jarrow a fortnight hence is very welcome, as supply has been inadequate for some time past. Both home and continental consumers continue to press for larger supplies, but manufacturers are unable to comply. Second hands are under no restrictions as to disposal of hematite. They have command of rather considerable quantities, but look for an early rise in values and are not disposed to undersell producers. Sales are reported at 74s. and upwards, according to quality.

Ironmaking Materials.

Business in the foreign ore trade is very quiet, but merchants adhere firmly to market rates at the equivalent of best Rubio at 23s. c.i.f. Tees. Blast-furnace coke supply is still far from what could be desired. Quotations are hardly so stiff as they have been, but sellers continue to ask 20s. for good medium qualities delivered to works in this district.

Manufactured Iron and Steel.

Encouraging conditions continue in the manufactured iron and steel trade, and operations at the works are being gradually extended. Demand for semi-finished steel is on a large scale. Continental semi-finished steel

prices are barely competitive with quotations for local products. Germany, the chief competitor, is stated not to have a great deal of material to offer. Most descriptions of finished material are finding a ready sale, and there are indications of a better export demand. Structural steel is in improved request, and departments turning out shipbuilding requisites and railway material are not only well employed, but are booking new orders. Iron bars have been advanced by 10s. per ton, common iron bars now being £10 15s.; best bars, £11 5s.; double best bars, £11 15s.; and treble best bars, £12 5s.

The Coal Trade.

The strength of the Northern coal trade position is holding out very satisfactorily, and those who predicted a coming weakness may find their expectations wide of the mark. For the present there is no falling away in any section, and the undertone is quite satisfactory to the collieries. Inquiries are coming in from many quarters, and a year's good trade is assured. For the next fortnight or so any available coals could be readily placed, and at full prices, but there is a very limited supply, and consequently the few transactions passing are for small lots at full ruling values. Best Northumberland steam coals for prompt shipment are at 16s. to 16s. 3d.; Tyne primes, 16s.; and other grades of large, 15s. 6d. Steam smalls are moving steadily from 9s. 6d. to 10s. 6d., according to brand. Durham steam coal is being well supported at 18s. to 18s. 6d. for large and 12s. to 12s. 6d. for smalls. Durham gas coals are maintaining the full range of recent prices, and are quoted 15s. 6d. for best and 16s. to 16s. 6d. for specials. Other grades are 15s. to 15s. 3d. There is an active demand for coking coals at 15s. to 15s. 6d. Bunkers are a shade easier at about 15s. 6d. to 16s. 6d. With the exception of blast-furnace kinds, there is a fairly good supply of coke, and some contractors are offering rather below direct quotations. Ordinary patent foundry sorts are plentiful at 18s. 6d. to 19s. 6d., and better qualities command 22s. to 24s. Gas coke is offered at 18s. 6d. to 19s.

SCOTLAND.

(From our own Correspondent.)

Quiet Conditions.

GENERALLY speaking, conditions in the steel, iron, and coal trades are comparatively dull, and immediate prospects are not particularly satisfactory. In most departments bookings, both on home and export account, are scarce and of rather small proportions.

Steel.

Producers of heavy steel continue to deliver fair quantities to shipbuilders, but an improvement in demand would be welcomed, especially in the case of plates, which have been quieter than sections for some time past. Export inquiries are said to have improved a shade, but very little in the way of new business has been placed so far. Steel sheets are unusually quiet for this time of the year, and galvanised descriptions in particular could do with extra business. So far as the supply of continental semis is concerned the position has improved. Tube makers are busy in practically all departments.

Iron.

Specifications for bar iron continue scarce, and there is keen competition for any business offered. The home price is unchanged at £10 5s., with export round about £9 15s. per ton. Re-rolled steel bars are not so busy as recently, but quotations are maintained at £8 home and £7 15s. per ton export. So far as pig iron is concerned, hematite has improved a shade of late, and additional furnaces may be restarted, but foundry qualities are in rather poor demand.

Scrap.

Scrap materials have a brisk demand, and with supplies rather scarce, firm prices are realised for any available material. Heavy steel is quoted about 75s., and cast iron from 75s. to 77s. 6d. per ton.

Exports and Imports.

Imports at Glasgow last week included 9000 tons of iron ore, 3000 tons of iron and steel from the Continent, and 1250 tons of chrome ore from Beira. Shipments included 6300 tons of steel and iron materials, and 468 tons of pig iron.

Manufactured Copper Reduced.

During the past week the price of manufactured copper was reduced on three occasions, amounting in all to £19 per ton, making the quotation for strong £119 per ton basis.

Clyde Engineers' Overtime.

It has been stated by the Clyde District Committee of the Amalgamated Engineering Union that considerable progress has been made in securing a reduction in the amount of overtime. Several firms have introduced double shifts instead of overtime, and thus employment has been found for an increased number of men.

Largest Dredger Built on River Cart.

The 2000-ton twin-screw bucket hopper dredger, just launched by Fleming and Ferguson, Ltd., Paisley, to the order of the Otago Harbour Board, Dunedin, New Zealand, is the largest vessel of this class that has ever been launched on the river Cart.

Coal.

Conditions in the coal trade have been undergoing a complete change during the past few weeks. The unusually severe weather in the early part of the year, coupled with restricted outputs, created a very firm market, but since the advent of warmer weather conditions, longer days, and increased outputs, a gradual weakening tendency has been noticeable. Home demands show a considerable falling off. Foreign demands are of meagre proportions, buyers abroad showing no disposition to purchase meantime, and the report that the placing of the Swedish State Railways' contracts has been postponed has not helped matters. The collieries freely offer fuel for prompt delivery, but as a rule have to make price concessions in order to secure even modest orders. Fuel is accumulating at colliery sidings, and outputs may have again to be curtailed. Aggregate shipments amounted to 228,119 tons, against 232,597 tons in the preceding week and 219,428 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Conditions.

THE conditions in the steam coal trade continue to be comparatively satisfactory, though they lack the strength of a few weeks ago. Some coals maintain a very strong tone, especially for shipment during the next fortnight or so, but there is more irregularity prevailing in other directions. From the point of view of exports, there is the satisfaction that the total for the whole of this district, including anthracite as well as steam qualities, marked a recovery as compared with the previous week. The returns of the Great Western Railway Company show that the quantity exported last week came to 604,355 tons, which compared with 437,765 tons for the previous week and with 411,902 tons for the corresponding week of last year. Whether the total for last week will be maintained depends very largely upon whether tonnage keeps up to requirements. The fear that the Continent would be a serious competitor by this time was well founded, as considerable quantities of tonnage are being attracted for the loading of German and Polish coals, and it is not surprising that great efforts are being made to make up for lost ground. At the present time tonnage at the disposal of local collieries is only just about sufficient to maintain activity. At the end of last week there were twenty idle tipping appliances, but over the week-end tonnage arrived in sufficient amount practically to balance the number of vacant berths. There is, however, no margin, and the chartering of tonnage is not on a really brisk scale. A fair number of orders are held, but the conditions on the whole can only be described as quiet, and while new orders are not coming along freely, it must also be said that tonnage is not offered in excessive quantity. There are, however, a few inquiries for coals of some importance, as the Brazilian Central Railways are in the market for 200,000 tons of superior large coals for delivery at Rio de Janeiro over a period of four months. Tenders have to be submitted on the 24th inst. The Spanish naval authorities are inquiring for 6000 tons of best Admiralty large coals for prompt shipment, and there is another inquiry from Spain for about 12,000 tons of sized coals.

Egyptian State Railways' Contract.

Tenders were opened at Cairo on Tuesday for the supply of 180,000 metric tons of locomotive coals for delivery at Alexandria, from May to August, for the Egyptian State Railways. This is a contract that always attracts a good deal of interest on the local market and abroad, as it affords some indication of what leading firms think about the trend of the market generally. The figures at which the existing contract was placed for 200,000 metric tons for delivery from February last to May were 28s. 5½d. and 28s. 6d. per ton c.i.f. Alexandria. When tenders for that business were placed the coal market was 2s. to 2s. 6d. per ton lower than at the moment, yet the prices which have been submitted for this new contract of 180,000 metric tons show only an increase of round about 1s. per ton. The lowest tender, as a matter of fact, is that of Tabb and Burletson, who have offered 60,000 tons at 29s. 6d. per metric ton c.i.f., while there are three firms—viz., T. Baynon and Co., Pyman, Watson and Co., and the Maris Export and Trading Company—which are reported to have offered to supply the full quantity of 180,000 tons at 29s. 9d. per metric ton, other tenders ranging up to over 30s. per metric ton. If 11s. 6d. is regarded as a reasonable freight risk, then the lowest prices submitted leave round about 18s. to cover the cost of the coals, &c., and from this it is evident that the belief prevails in some quarters that coal prices will come back before very long to the old schedule figures. It will, of course, be a very serious matter if market conditions become so bad that values fall back to that level, though the predominant feeling is that they are scarcely likely to revert quite to it. It is, however, reported that the question of the regulation of coal prices and output is again to come up for consideration by the coalowners very shortly, and in all the circumstances it is probably wise that no time should be lost in this respect.

Miners' Affairs.

A special delegate conference of the South Wales Miners' Federation was due to begin on Thursday of this week, and it may last two or three days. The subject to be discussed is the question of the reorganisation of the Federation. Proposals will be submitted for dealing with this matter, and it is understood that the general idea underlying them is that the organisation should be more centralised, and that several constituent districts should be merged, with a view to a reduction of administration expenses.

Current Business.

There has not been much actual change in values of steam coals this week as compared with last, but the market presents a rather more irregular appearance. Most of the collieries are well stemmed for this month, and in the case of some of the leading grades well into May, but general business is not quite as active as of late and the market for coals for delivery ahead displays an easier tendency. The fact is that buyers abroad appear to be inclined to hold their hands in the expectation that values will come back to some extent. Best Admiralty large coals are round about 21s. 6d. to 22s. for prompt delivery, and small coals of superior quality 14s. 6d. to 15s. There is no change in patent fuel, while pitwood is about 27s. 3d.

BRITISH WATERWORKS ASSOCIATION.

THE eighteenth annual general meeting and conference of the British Waterworks Association will be held at Portsmouth from July 2nd to 5th next, by invitation of the Chairman and Board of Directors of the Portsmouth Waterworks Company. The following programme has been arranged:—

On Tuesday, July 2nd, at 11 a.m., there will be a meeting of the Executive Committee of the Association in the Grand Jury Room, Guildhall, Portsmouth. It will be followed at 1 p.m. by luncheon at the Queen's Hotel for the Members of the Committee, at the invitation of the President-elect, Mr. Frederick Blake, F.S.I., Chairman of the Portsmouth Waterworks Company. In the afternoon at 2.15 the annual general meeting and conference of the Association will be opened in the Banqueting Room of the Guildhall. After the transaction of the usual business, the President for the ensuing year will be elected and installed, and will deliver an address. The following papers will then be read and discussed:—"The Desirability of River Gaugings for Various Purposes," by Mr. E. A. Sandford Fawcett, M. Inst. C.E.; and "Extremes of Rainfall over the British Isles," by Dr. J. Glasspoole. In the evening at 7 p.m. there will be a reception at the Guildhall by the President, which will be followed at 7.30 p.m. by the annual dinner in the Main Hall of the Guildhall.

On the Wednesday morning, at 10 a.m., the reading and discussion of papers, at the Guildhall, will be resumed, the papers taken being:—"The Quality and the Method and Results of Treatment of the Portsmouth Water Supply," by Dr. Ernest V. Suckling; and "The Hydrology of the Portsmouth District," by Mr. D. Halton Thomson, Assoc. M. Inst. C.E., M.I. Mech. E., Engineer to the Portsmouth Waterworks Company. In the afternoon visits will be paid to the Waterworks Company's Farlington filtration works and main service reservoirs, and to the Havant and Bedhampton Main pumping stations and springs. In the evening, from 7.30 p.m. to 10 p.m., the Lord Mayor will hold a Reception at the Guildhall.

On Thursday, July 4th, 1929, there will be an all-day tour to Southampton and the New Forest; while on the Friday there will be visits to places of local interest.

CONTRACTS.

THE BRITISH REINFORCED CONCRETE ENGINEERING COMPANY, Ltd., of Stafford, has received an order for the supply of upwards of 100,000 square yards of B.R.C. fabric ref. No. 64 for reinforcing roadways, for the Liverpool Corporation.

ALFRED HERBERT, Ltd., informs us that its licencee in Belgium, La Soc. Anon. Ateliers J. Hanrez, Monceau-Sur-Sambre, has received an order for two No. 16 Atritors for the Fabrique Nationale d'Armes de Guerre, Herstal (Belgium), and that the Riley Stoker Corporation, which manufactures the Atritor under licence for sale in the United States of America, has received orders for four machines from the Byllesby Plant in Oklahoma, for three machines from the Sunbury Converting Company, Sunbury, Pa., and for three machines from the Frasier Company in Canada.

BEYER PEACOCK AND CO., Ltd., have received from the Bengal-Nagpur Railway Company (5ft. 6in. gauge) an order for sixteen "Beyer-Garratt" articulated locomotives. These locomotives, which will weigh about 232 tons in working order, will be the largest engines of any type ever designed or manufactured in Europe for any part of the world. They will have a 4–8–0, 0–8–4 wheel arrangement and the maximum axle-load will be 20 tons. The tractive effort at 85 per cent. boiler pressure will be 70,000 lbs., with driving wheels of 4ft. 8in. The boiler pressure will be 210 lbs., and 10,000 gallons of water and 14 tons of coal will be carried. The engines will be built under the supervision of Sir John Wolfe Barry and Company, consulting engineers to the Bengal-Nagpur Railway.

INSTITUTION OF ENGINEERS-IN-CHARGE.—The twenty-ninth annual dinner of the Institution of Engineers-in-Charge was held in the Royal Venetian Chamber, Holborn Restaurant, on Friday, April 12th, Mr. H. G. Burford, President, occupying the chair. The room was quite full, over two hundred and fifty members and guests being present. The speech making was excellent. For the most part it was light and evanescent, as after dinner speaking should be, and there was a great deal of hearty laughter, particularly over the witticisms of Mr. J. Wardlaw Milne and Dr. Ormandy in connection with Industry and Transport. A light musical programme was interspersed between the toasts. A very good evening.

THE INVENTION OF THE CARBON INCANDESCENT ELECTRIC LAMP.—In the "Journal" of the Institution of Electrical Engineers, published on Monday last, there is an interesting paper by Mr. A. A. Campbell Swinton, entitled "The Part Played by Mr. St. George Lane Fox Pitt in the Invention of the Carbon Incandescent Electric Lamp, and the Modern Method of Electric Lighting." In this paper Mr. Swinton puts it on record that it was Mr. Lane Fox Pitt who first protected, on March 20th, 1879, and more specifically patented in 1880, the method of treating an incandescent lamp filament by raising it to an incandescent state by sending a current through it while immersed in hydrocarbon, a process which became known as "flashing." Sir Hiram Maxim came after Mr. Lane Fox Pitt. The patent of Sawyer and Man, usually known as the "Chessborough" patent, owing to the name of the patent agent who took it out, dates from 1878, about a year before Mr. Lane Fox's (subsequently Lane Fox Pitt) protection, but, as will be seen if the specification is carefully studied, it has nothing to do with filament incandescent lamps at all. The patent is for what were afterwards called semi-incandescent or semi-arc lamps, in which there was no filament and a carbon pencil was employed. As showing the importance ascribed at the time to Mr. Lane Fox Pitt's several patents, Mr. Swinton mentions that he has a copy of an executed indenture of agreement, made in July, 1890, between the Brush Electrical Engineering Company, Ltd., and others and Mr. St. George Lane Fox (afterwards Lane Fox Pitt), which after mentioning that Mr. Pitt had agreed to grant to the licensors a licence to use his inventions as set out in the schedule, states that the Edison and Swan Company agreed to take a licence to use the patents on payment of specified royalties. The patent was bad in law, but however legally construed, it was an altogether remarkable, exceedingly creditable, and extraordinarily important contribution to science by Mr. St. George Lane Fox Pitt, who was not then twenty-three years of age.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
(1) Native	19/- to 21/-
(1) Spanish	21/-
(1) N. African	21/-
N.E. Coast—	
Native	18/- to 21/-
Foreign (c.i.f.)	23/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	3 17 0	—
No. 1 Foundry	3 15 0	—
No. 3 Foundry	3 12 6	—
N.E. Coast—		
Hematite Mixed Nos.	3 14 0	3 14 0
No. 1	3 14 6	3 14 6
Cleveland—		
No. 1	3 11 0	3 11 0
Silicious Iron	3 11 0	3 11 0
No. 3 G.M.B.	3 8 6	3 8 6
No. 4 Foundry	3 7 6	3 7 6
No. 4 Forge	3 7 0	3 7 0
Mottled	3 6 6	3 6 6
White	3 6 6	3 6 6
Midlands—		
(3) Staffs.—	(*Delivered to Station*)	
All-mine (Cold Blast)	—	—
North Staffs. Forge	3 11 0	—
„ „ Foundry	3 15 0	—
(3) Northampton—		
Foundry No. 3	3 9 0	—
Forge	3 5 0	—
(1) Derbyshire—		
No. 3 Foundry	3 12 6	—
Forge	3 8 6	—
(3) Lincolnshire—		
No. 3 Foundry	3 6 0	—
No. 4 Forge	3 0 0	—
Basic	3 2 6	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 4 6 (a) / 4 7 0 (b) / 4 11 0 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	10 5 0	9 15 0
Best	—	—
N.E. Coast—		
Iron Rivets	11 10 0	—
Common Bars	10 15 0	—
Best Bars	11 5 0	—
Double Best Bars	11 15 0	—
Treble Best Bars	12 5 0	—
Lancs.—		
Crown Bars	10 10 0	—
Second Quality Bars	10 0 0	—
Hoops	13 0 0	—
S. Yorks.—		
Crown Bars	10 10 0	—
Best Bars	11 10 0	—
Hoops	12 10 0	—
Midlands—		
Crown Bars	9 15 0 to 10 0 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	8 12 6 to 8 17 6	—
Gas Tube Strip	10 17 6	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates	10 10 0	10 10 0
Ship Plates, ½in. and up	8 7 6	7 12 6
Sections	7 17 6	7 2 6
Steel Sheets, ¼in.	8 15 0	8 12 6
Sheets (Gal. Cor. 24 B.G.)	13 10 0	13 12 6 to 13 15 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	8 7 6	—
Angles	7 17 6	—
Boiler Plates	12 15 0	—
Joists	7 17 6	—
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	8 2 6	—
Soft Billets	6 17 6	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 0 0	—
Light Rails	8 5 0 to 8 10 0	—
Billets	6 15 0 to 9 0 0	—
Manchester—		
Bars (Round)	8 17 6	—
„ (Small Round)	8 10 0 to 8 12 6	—
Hoops (Baling)	10 0 0	9 15 0
„ (Soft Steel)	9 0 0	8 15 0
Plates	8 12 6 to 8 17 6	—
„ (Lancs. Boiler)	9 12 6 to 9 17 6	—
Sheffield—		
Siemens Acid Billets	8 15 0 to 9 0 0	—
Hard Basic	9 2 6 and 9 12 6	—
Intermediate Basic	7 12 6 and 8 2 6	—
Soft Basic	7 0 0	—
Hoops	9 10 0	—
Soft Wire Rods	7 12 6	—
Midlands—		
Small Rolled Bars	8 2 6 to 8 5 0	—
Billets and Sheet Bars	6 7 6 to 6 10 0	—
Sheets (20 W.G.)	11 10 0 to 12 0 0	—
Galv. Sheets, f.o.b. L'pool	13 7 6 to 13 10 0	—
Angles	7 17 6	—
Joists	7 17 6	—
Tees	8 17 6	—
Bridge and Tank Plates	8 12 6	—
Boiler Plates	9 15 0	—

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	18/3 to 18/6
Block Tin (cash)	205 2 6
„ „ (three months)	205 17 6
Copper (cash)	75 0 0
„ (three months)	72 5 0
Spanish Lead (cash)	24 5 0
„ „ (three months)	23 15 0
Spelter (cash)	26 10 0
„ (three months)	26 6 3
Manchester—	
Copper, Best Selected Ingots	83 0 0
„ Electrolytic	86 0 0
„ Strong Sheets	112 0 0
„ Tubes (Basis Price), lb.	0 1 3½
Brass Tubes (Basis Price), lb.	0 1 1½
„ Condenser, lb.	0 1 3½
Lead, English	26 2 6
„ Foreign	24 10 0
Spelter	26 15 0
Aluminium (per ton—raw ingot)	£95

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	3/2 per lb.	
Ferro Tungsten	2/10 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£25 0 0	7/6
„ „ 6 p.c. to 8 p.c.	£24 0 0	7/-
„ „ 8 p.c. to 10 p.c.	£23 10 0	6/-
„ „ Specially refined		
„ „ Max. 2 p.c. carbon	£38 0 0	12/-
„ „ „ 1 p.c. carbon	£40 0 0	15/-
„ „ „ 0·70 p.c. carbon	£45 0 0	17/-
„ „ „ carbon free	1/2 per lb.	
Metallic Chromium	2/6 per lb.	
Ferro Manganese (per ton)	£13 15 0 for home; £13 10 0 for export	
„ Silicon, 45 p.c. to 50 p.c.	£12 0 0 scale 5/- per unit	
„ „ 75 p.c.	£19 10 0 scale 6/- per unit	
„ Vanadium	13/9 per lb.	
„ Molybdenum	3/8 per lb.	
„ Titanium (carbon free)	1/- per lb.	
Nickel (per ton)	£170 to £175	
Ferro-Cobalt	9/6 per lb.	

FUELS.

SCOTLAND.

(*Prices not stable.*)

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	14/-
„ „ Eil	16/-
„ „ Splint	17/- to 17/6
„ „ Trebles	14/-
„ „ Doubles	13/-
„ „ Singles	12/-
Ayrshire—	
(f.o.b. Ports)—Steam	16/6
„ „ Jewel	17/6
„ „ Trebles	13/9
Fifeshire—	
f.o.b. Methil or Burntisland—Steam	12/- to 13/6
Screened Navigation	18/6
Trebles	13/6
Doubles	12/6
Singles	12/-
Lothians—	
(f.o.b. Leith)—Best Steam	13/3
Secondary Steam	13/-
Trebles	13/6
Doubles	12/6
Singles	11/9

ENGLAND.

(8) N.W. Coast—	
Steams	25/-
Household	39/6 to 52/-
Coke	23/6 to 24/-
Northumberland—	
Best Steams	16/- to 16/3
Second Steams	15/6
Steam Smalls	10/6 to 11/-
Unscreened	14/- to 14/6
Household	21/- to 27/-
Durham—	
Best Gas	15/6
Second	15/- to 15/3
Household	21/- to 27/-
Foundry Coke	22/6 to 25/-
Sheffield—	Inland.
Best Hand-picked Branch	27/- to 28/6 —
Derbyshire Best Bright House	23/6 to 25/- —
Best House Coal	21/- to 22/- —
Screened House Coal	18/- to 19/- —
„ „ Nuts	17/- to 19/- —
Yorkshire Hards	15/6 to 16/6 —
Derbyshire Hards	15/6 to 16/6 —
Rough Slacks	8/6 to 9/6 —
Nutty Slacks	6/- to 7/- —
Smalls	3/6 to 4/- —
Blast-furnace Coke (Inland)	14/6 at ovens —
Furnace and Foundry Coke (Export), f.o.b.	20/6 to 21/6

Cardiff— (9) SOUTH WALES.

Steam Coals:	
Best Smokeless Large	21/6 to 22/-
Second Smokeless Large	21/- to 21/3
Best Dry Large	21/- to 21/6
Ordinary Dry Large	20/- to 21/-
Best Black Vein Large	21/- to 21/3
Western Valley Large	20/3 to 20/6
Best Eastern Valley Large	19/6 to 20/-
Ordinary Eastern Valley Large	19/- to 19/6
Best Steam Smalls	14/6 to 15/-
Ordinary Smalls	13/- to 14/6
Washed Nuts	20/- to 25/-
No. 3 Rhondda Large	21/- to 22/-
„ „ Smalls	15/- to 16/-
No. 2 „ Large	18/6 to 19/-
„ „ Through	17/- to 18/-
„ „ Smalls	13/6 to 14/-
Foundry Coke (export)	27/- to 37/-
Furnace Coke (export)	19/- to 21/-
Patent Fuel	20/6 to 21/6
Pitwood (ex ship)	27/3 to 27/6
Swansea—	
Anthracite Coals:	
Best Big Vein Large	33/- to 35/-
Seconds	25/- to 29/-
Red Vein	24/- to 27/-
Machine-made Cobbles	40/- to 43/6
Nuts	40/- to 44/-
Beans	23/6 to 25/6
Peas	16/6 to 17/6
Breaker Duff	9/6 to 10/-
Rubbly Culm	10/- to 10/6
Steam Coals:	
Large	18/- to 19/-
Seconds	17/- to 18/-
Smalls	11/- to 13/-
Cargo Through	15/9 to 16/9

(1) Delivered. (2) Net Makers' Works. (3) f.o.t. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham. (*d*) Rebate 12/6 joists and 10/- all other materials if home consumers confine purchases solely to British products.

French Engineering Notes.

(From our Correspondent in Paris.)

Trade Improvement.

In nearly all branches of the engineering trades there is plenty of work, practically the whole of it being for home requirements, and if nothing should interfere with the carrying out of the various programmes, there is no reason why the activity should not continue. It is true that there is a continuous advance in costs, and wages are being adjusted to the higher cost of living, but prices of raw material are not increasing to the extent that had been anticipated. The higher production costs do not, at present, affect the home business. Manufacturers, however, are well aware that costs are levelling up to those in other countries, and they are laying themselves out in consequence to economise production by employing the best labour-saving machinery and the most efficient methods. This course is particularly observable in the motor car trade, in which the situation is peculiarly complicated by the manœuvres of the General Motors Corporation, which has already financed the Opel business in Germany, with the result that the prices of Opel cars have been reduced considerably, and that has inaugurated a phase of competition that is regarded as serious by makers of small cars. There have been repeated rumours to the effect that negotiations are in progress between the General Motors and one of the biggest makers in France, who is now turning out 480 cars a day, and, although this is denied, it appears to be fairly certain that American finance is endeavouring to secure some control of the continental motor car trade. Another phase of activity is the placing of orders for rolling stock by the railway companies, one of which is said to be on the point of placing orders to the value of more than 20 million francs. In almost every case a large percentage of German material is specified. As much material as possible is now being obtained from Germany on account of reparations, but this is done almost entirely through French makers, who insist upon having some control over the German material brought into the country.

The Navy.

The shipyards are launching this month 31,000 tons of vessels for the French navy and some submarines and other craft for Poland. At Lorient a minelayer, two submarines and a destroyer have left the stocks. The minelayer "Pluton" is built for speed and a long range of action, and, carrying about a thousand mines, it will be able to operate at any required distance from its base. It has an overall length of 152 m. and a beam of 15·55 m. Its displacement is 5300 tons. Propelled by turbines of 57,000 horse-power, it is expected to have a speed of 30 knots. The first-class submarines "Henri Poincaré" and "Poncelet" have a displacement at the surface of 1560 tons. Their length is 92 m. and width 8 m. They will be propelled by internal-combustion engines, each of 3000 horse-power. There will be ten torpedo tubes. The destroyer "Aventurier," or "squadron torpedo boat," as it is called, is an old vessel which was on the stocks for a South American Government in 1915 and was requisitioned by the French Government. She has been entirely refitted, and has oil-fired boilers taken out of German torpedo boats. On the stocks left vacant at Lorient there will be started immediately the construction of a 6000-ton vessel for replenishing submarines. It will have a length of 115 m., a breadth of 18 m., and will draw 5·8 m. of water. A speed of 18 knots will be obtained with two internal-combustion engines, giving a total of 8000 horse-power. At Saint-Nazaire a submarine has been launched, and another will leave the stocks shortly at Nantes. All these submarines are of the same type. The aircraft-carrier "Commandant Teste," having a displacement of 10,160 tons and a length of 256 m., has been launched at Bordeaux. Its engines will develop 21,000 horse-power, and it will steam at 20·5 knots. The only other aircraft carrier at present in the French navy is the old battleship "Béarn," which was transformed for the purpose. A fire occurred on that ship last week, without, however, doing considerable damage. At Brest there will be launched in a few days a 10,000-ton cruiser, to which the name of "Foch" has been given.

Electric Supply.

The consumption of electricity in Paris has so far exceeded the most sanguine estimates of a few years ago that an extensive programme has had to be prepared to ensure an adequate supply, alike from the hydro-electric installations in the Massif Central and from local power plants, the whole being so arranged that they can be made dependent on each other in the event of failure of any one of them. For the moment, the most important work undertaken is the extension of the Issy-les-Moulineaux Power Station, in which steam is generated in five boilers, each with 19,500 square feet of heating surface, and designed for a working pressure of 630 lb. per square inch, and to superheat the steam to 450 deg. Cent. The coal pulverising and drying plant has a capacity of 900 tons a day. The new plant will have a productive capacity of 175,000 kW, which, for the time being, will be sufficient for that part of the city lying to the south of the Seine, while on the north the requirements are supplied by the Saint-Ouen Power Station, which has a capacity of 400,000 kilowatts.

Morocco Railways.

The valuable resources of Morocco encouraged railway enterprise to an extent that has been fully justified by results, and in some cases the importance of railways has been considerably increased by the discovery of phosphates while the line was in course of construction. This was the case with the railway recently opened between Casablanca and Marrakech, a distance of 150 miles. It is estimated that, in the territory served by this railway, there are 200 million tons of ore containing 75 per cent. of tricalcic phosphate, while the quantity of poorer mineral capable of being mined is regarded as incalculable.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

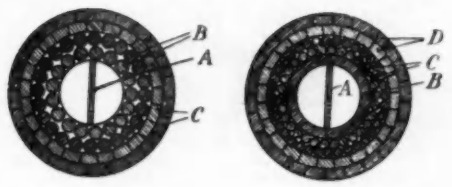
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

TRANSMISSION OF POWER.

281,692. December 1st, 1927.—HIGH-TENSION ELECTRIC CABLES, *Siemens-Schuckertwerke Aktiengesellschaft, of Berlin-Siemensstadt, Germany.*

This invention has for its object to provide a hollow cable, for exposed or overhead electric wires, made of an alloyed aluminium of high conducting power and of a high degree of

Nº281,692



strength. The left-hand drawing shows a hollow cable of aluminium having a supporting member A and round wires B, which are surrounded by two layers of flat wires C. Upon the supporting member A in the right-hand drawing, there is a layer of flat wire B, over which the round wires C and the flat wires D are then twisted or wound.—*March 1st*, 1929.

282,386. December 10th, 1927.—MEANS FOR PREVENTING FAULTY ACTION DUE TO THE EFFECT OF THE MAGNETIC FIELD OF THE CURRENT CIRCUIT IN CABLE PROTECTIVE DEVICES, *Siemens-Schuckertwerke Aktiengesellschaft, of Berlin-Siemensstadt, Germany.*

The invention, which has for its object the prevention of faulty action in cable protective devices, can be applied to systems with a subsidiary conductor, when the current in the subsidiary conductor is lagging, which is the case, for instance, in cables in which the subsidiary conductor is arranged centrally or practically centrally in the interior of a cable. It is also applicable in the arrangements in which the subsidiary conductor is arranged at the outer circumference of the main conductor, in which case the current in the subsidiary conductor leads relatively to the main current; also in any position of the subsidiary conductor between these two positions. A is the parallel conductor with a lagging current and B the parallel conductor with a leading current. C is a differential transformer which is controlled by both currents in A and B, and in the third winding of which

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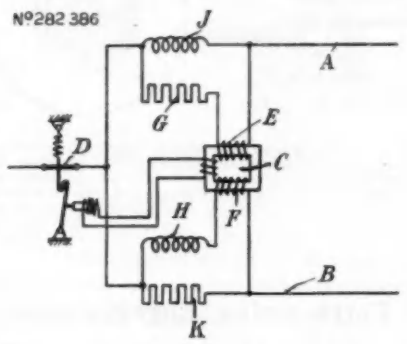

is induced a voltage when the ratio of the two currents acting on it deviates from the correct value. The voltage then produced in the third coil is used for opening a switch D in the total conductor. In order to obtain currents of the same phase in the two operative coils E and F of the differential transformer C, the coil E, which is connected to the conductor A, is connected in series with an ohmic resistance G, and this series connection is bridged over a choke J in the conductor A. The current component passing through the coil E and the resistance G in series with the latter, is then leading relatively to the current passing through the parallel conductor A. On the other hand, the operative coil F of the differential transformer C, connected to the conductor B, is connected in series with a choke H, and this circuit is bridged over an ohmic resistance K in the conductor B. The current component passing through the operative coil F and the choking coil H in series with the latter, will then be lagging relatively to the current passing through the conductor B. The single values can be balanced with each other in such a manner that the currents in the coils E and F will have exactly or approximately the same phase.—*March 7th*, 1929.

MEASURING AND TESTING INSTRUMENTS.

286,308. March 2nd, 1928.—ELECTRO-DYNAMOMETERS, Siemens and Halske Aktiengesellschaft, of Berlin-Siemensstadt, Germany.

The two rectangular field coils A B fastened to the pressboard discs C D are mounted parallel to one another, and, preferably, slightly out of axial alignment in order to obtain a better scale reading. The distance separating them, measured between their adjacent ends, is greater than the width of one coil measured in the axial direction. On the bearing pedestals E and F there is a member G, consisting of two opposite cylindrical portions with a base, cover and radial walls H, forming two chambers having the shape of cylinder sectors. The bearing screw K for the shaft of the movable system is inserted at the bottom of this member, whereas the other bearing screw L is fitted in a bridge, bridging the two bearing pedestals E and F. To the shaft, acted on by two springs M, two aluminium sheets N O are fastened for the air damping of the index, and they carry the excentrically mounted coils J and K by means of bent plates L. The total diameter of the two coils fastened to the aluminium sheet, measured across the outermost former sides, is equal to the mean diameter of the fixed field coils, but variations are permissible. In order to obtain different measuring ranges in the ratio 1 : 2 : 4, the four windings are either connected in series or in parallel, with one another, or partly in parallel and partly in series. The new measuring set is said

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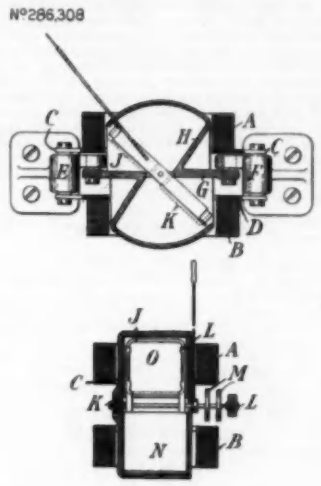

to be very suitable for power measurements with three-phase current, with the two astatic power-indicating measuring sets connected to one another in the manner indicated.—*March 7th*, 1929.

MACHINE TOOLS AND SHOP APPLIANCES.

285,497. February 17th, 1928.—MANUFACTURE OF INSULATING TAPES OR THE LIKE, *International General Electric Company, Incorporated, of 120 Broadway, New York.*

The invention relates to a machine for manufacturing insulating tapes which are composed of woven textile fabric and on which is laid a layer of rubber, oil or varnish by pasting, rolling or impregnating. The cloth texture A is drawn from the roller B, and then conducted to the drying oven over a roller C, which serves simultaneously as a support for the pasting pallet D,

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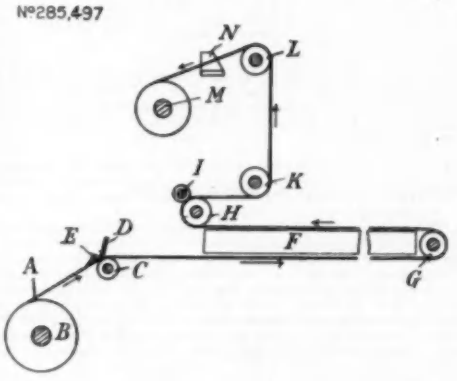

used for effecting a regular distribution of the pasting mass E. The pasted texture led round by the roller G passes the drying device F twice, and over the hardened steel roller H, on which lightly pressed cutting discs I run and cut the texture into strips. From there the texture is conveyed over rollers K and L to the winding-on roller M, on to which it is rolled. Between the winding-on roller and last roller are arranged rake or comb-like members N, which separate any strips which may be still clinging together.—*March 7th*, 1929.

307,164. January 24th, 1928.—INDEXING MECHANISM FOR GRINDING MACHINES, The Gear Grinding Company, Ltd., A. H. Orcutt, and J. W. Snarry, Anne-road, Handsworth.

This invention is virtually an effort to reduce the possible errors of indexing in a machine used for such purposes as the grinding of the teeth of gear wheels by the interposition

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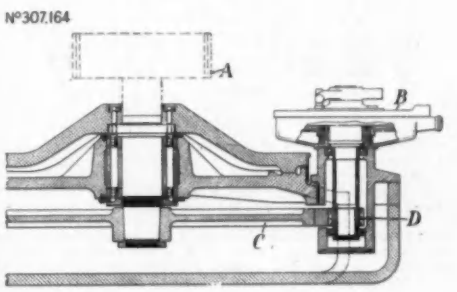


between the work piece and the indexing mechanism of a toothed reduction gear. In the drawing the workpiece is shown at A, and the indexing mechanism, which is not definitely specified, at B. It is stipulated that the two wheels C and D which connect these two units shall be "constructed with the same care and accuracy as that employed in the production of the indexing disc."—*March 7th*, 1929.

WELDING.

306,785. July 17th, 1928.—ELECTRODES FOR ARC WELDING, Weldrics (1922), Ltd., and Archibald Douglas Anderson, both of Station-road, Beeston, Nottinghamshire.

This invention relates to electrodes for arc welding and similar purposes and of the kind comprising an iron core provided with a fibrous winding and an outer coating, including silicate of soda and blue asbestos. By means of the invention it is said to be

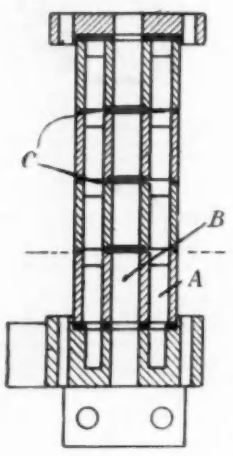
possible to obtain improved electrodes which are particularly suited for the purpose of arc welding. Blue asbestos is finely disintegrated and mixed with silicate of soda and a small percentage of iron oxide to form a paste. The proportion of blue asbestos to silicate of soda is about 98 per cent. by weight, and the consistency of the silicate of soda gives about 40 deg. Twaddell. This paste is fed to the hopper or cylinder of an extrusion machine or press, and is forced through the die thereon when the machine is operated. Simultaneously with this operation of the machine, the rod, having been first wound with a mixture of blue and white fibrous asbestos, is introduced into the machine and passed out through the extrusion die thereof and is thus coated with the paste. The fibrous asbestos may have a cross section of about 2 mm. and the pitch of the windings on the rod may be about 4 mm. After the application of the paste to the rods, they are supported in a suitable frames, and after dipping in a bath consisting of a solution of potassium carbonate and caustic potash, they are artificially dried and are then ready for use.—*February 17th*, 1928.

MISCELLANEOUS.

279,468. October 20th, 1927.—Yarn Singeing Devices, Maschinenbau Aktiengesellschaft Langenthal, Langenthal, Switzerland.

In this yarn-singeing device, the gas for producing the necessary flame is admitted into the annular chamber A, and escapes

No 279 468

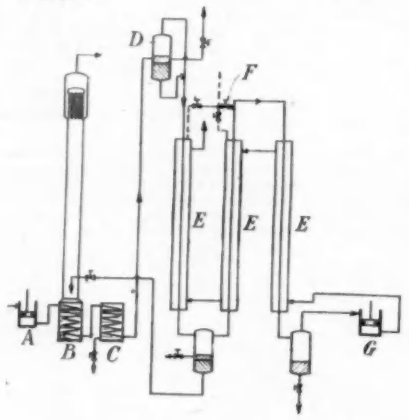


into the central passage B, through which the yarn is drawn at a high speed, by the circular slits C C. The slits are formed as shown in the drawing and the result, it is claimed, is that a flame is produced which effects an even singeing of the yarn throughout its circumference.—*February 20th*, 1929.

281,288. November 21st, 1927.—Extraction of Ammonia from Coke Oven Gas, Gesellschaft für Linde's Eismachinen Aktiengesellschaft, Höllriegkskreauth, near Munich, Germany.

The principal claim is for the extraction of ammonia from coke oven gas in the form of high-percentage ammonia water, characterised in that the gas, from which tar and the main content of water have been removed by cooling to about 40 deg. Cent., but from which the naphthalene has not yet been removed, is compressed, is cooled to about normal temperature after the separation of the naphthalene in liquid form at 40 deg. to 50 deg. Cent., together with the weak ammonia water that separates out during compression, and then, while the cooling is con-

No 281,288

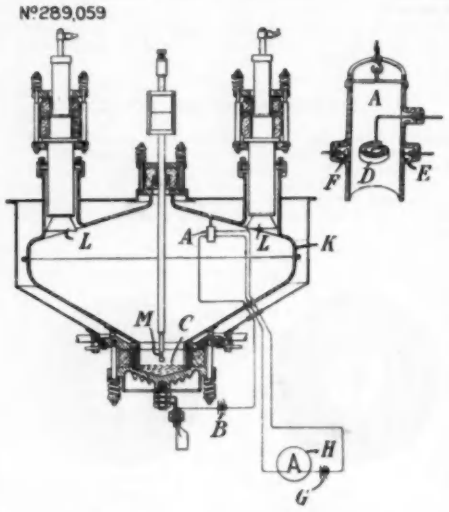


tinued to approximately 0 deg., is washed with a small quantity of fresh water in counter current, the pressure and the temperature of the gas being utilised for processes requiring a different pressure and degree of cold. In the drawing we reproduce the compressor is shown at A, which raises the temperature of the gas to about 140 deg. It passes through the heating coil of the column B, and is then cooled to about 50 deg. in the cooler C. The naphthalene and ammonia liquor are separated out at D, and the liquor is used to wash the gas, to eliminate the remaining ammonia in the towers E E E. A small proportion of fresh water is added at F. The gas is finally expanded down to a temperature of — 60 deg. in the engine G.—*February 21st*, 1929.

289,059. April 19th, 1928.—Apparatus for Measuring a Low Gaseous Pressure, such as that of a Vapour Electric Discharge Device, *The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C. 2.*

This invention relates to apparatus for measuring low values of pressure of a gas or vapour, and has for its principal object the provision of an improved apparatus that is robust in construction and may be utilised accurately to measure or to produce an effect dependent on the low gaseous pressure within the evacuated vessel of a vapour electric discharge device, such as a mercury arc rectifier. The apparatus A is provided with an auxiliary anode or electrode F, which is connected to the cathode C through a battery B, and with electrodes D and E, which are situated near the electrode F and are insulated from the electrode F, and from one another by an insulation support and are interconnected through a source G and a device H, which may be an indicating meter, an apparatus for controlling the operation of a vacuum pump connected to the vessel K. The apparatus A is preferably situated near one of the anodes L in order that the pressure in the vicinity of the anodes may be measured. In the operation of the rectifier, the arc is started between the cathode C and the anodes L by means of a starting electrode M,

No 289,059

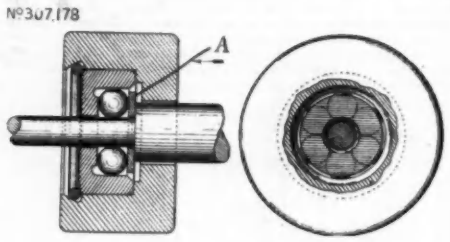


which is temporarily brought into contact with the surface of the mercury. When the arc is established between the cathode and the anodes, an arc is also started between the cathode and the electrode or auxiliary anode F, and the spiral-shaped electrode D picks up positive ions at a rate dependent on their concentration, which, in turn, is dependent for a given current on the vapour pressure in the vessel K. Under these conditions, the electrode E attracts to itself sufficient electrons to neutralise the positive ions which find their way to the electrode D, and a current dependent on the vapour pressure is supplied to the device H.—*March 7th*, 1929.

307,178. February 8th, 1928.—Ball Bearings, W. and T. Avery, Ltd., Soho Foundry, Birmingham, and W. Timson.

This ball bearing is intended for use in connection with the indicating mechanism of automatic weighing machines. It is pointed out that with the normal type of ball bearing there is a

No 307,178



tendency for the balls to lag behind the shaft as it rotates, and cause inaccuracies in the indications. The inventors consequently provide a washer A on the end of the shaft, which bears against the balls at their diameter and helps to make them rotate with the shaft. There is a slight end pressure on the shaft.—*March 7th*, 1929.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

Institution of Mechanical Engineers.—Storey's-gate, St. James's Park, London, S.W. 1. "The Standardisation of Keys and Keyways," by Mr. William Reavell. 6 p.m.

Junior Institution of Engineers.—39, Victoria-street, Westminster, London, S.W. 1. "Early Aviation," by Lt.-Col. J. T. C. Moore-Brabazon. 7.30 p.m.

Royal Institution of Great Britain.—21, Albemarle-street, Piccadilly, London, W. 1. Discourse, "History of the Grand Canyon, Yellowstone National Park," by Professor Owen T. Jones, F.R.S. 9 p.m.

The Physical Society.—At the Imperial College of Science, Imperial Institute-road, South Kensington, S.W. 7. The fourteenth Guthrie Lecture will be delivered by Professor P. W. Bridgman, Hollis Professor of Mathematics and Natural Philosophy in Harvard University, on "The Properties of the Elements Under High Pressures." 5 p.m.

Worshipful Company of Turners.—At the Mansion House, London. Fortieth prize competition for turning in wood and metal. Prize distribution by the Right Hon. the Lord Mayor. 3 p.m.

SATURDAY, APRIL 20TH.

Institution of Municipal and County Engineers.—Southern District meeting. At the Council House, Corn-street, Bristol. "Description of the New Power Station, Portishead," by Mr. H. Farady Proctor. 10.30 a.m.

North of England Institute of Mining and Mechanical Engineers.—In the Lecture Theatre of the Institute, Newcastle-upon-Tyne. The following papers will be open for discussion:—"Roof Control on Longwall Faces," by Mr. John F. C. Friend; "Diamond Boring Applied to Tapping Drowned Areas Underground," by Mr. F. E. Smyth; "Land Drainage," by Mr. H. C. Pawson; "The Laws of Motion of Particles in a Fluid," by Mr. R. G. Lunnon. The following papers will be read:—"Boring Against Workings Likely to Contain an Accumulation of Water or other Liquid Matter, and a Method of Negotiating a Fault," by Mr. C. H. Leeds; "The X-ray Analysis of Coal: The Radiographic Variables and their Control," by Mr. C. Norman Kemp. 2.30 p.m.

MONDAY, APRIL 22ND.

Institution of Automobile Engineers.—Graduates' meeting, The College, Loughborough. "Steering Gears," by Mr. H. M. Smith. 7 p.m.

Institution of Automobile Engineers: North of England Centre.—At the University, Department of Applied Science, St. George's-square, Sheffield. "Recent Developments in the Study of the Fatigue of Materials," by Dr. H. J. Gough. 7 p.m.

Institution of Mechanical Engineers.—Storey's-gate, St. James's Park, London, S.W. 1. Graduates' Section. Informal discussion. "The Engineer as a Salesman," opened by Mr. H. R. Steward. 6.30 p.m.

TUESDAY, APRIL 23RD.

Chadwick Public Lectures.—The Institution of Mechanical Engineers, Storey's-gate, Westminster. "What Health and Civilisation Owe to Engineering," by Mr. C. E. Stromeyer. 8 p.m.

Institution of Automobile Engineers.—Engineering and Scientific Club, Queen-street, Wolverhampton. "Central Lubrication of Chassis Bearings," by Mr. H. W. Pitt. 7.30 p.m.

Institution of Civil Engineers.—Great George-street, Westminster, S.W. 1. Ordinary meeting. Papers to be submitted for discussion:—"The Arapuni (New Zealand) Hydro-electric Development," by Mr. Frederick William Adolph Handman; and "The Tata Power Company's Hydro-electric Project," by the late Mr. Noshervan Jehanghir Manockjee Cursetjee. 6 p.m.

WEDNESDAY, APRIL 24TH.

Institution of Civil Engineers.—Great George-street, Westminster, S.W. 1. Students' meeting. Annual general meeting of the Association of London Students. 6.30 p.m.

Institution of Production Engineers.—In the Council Room of the Society of Motor Manufacturers and Traders, Ltd., 83, Pall Mall, London, S.W. 1. "Factory Rationalisation or the Production Director and Business Rejuvenation," by Mr. H. E. Taylor. 7.30 p.m.

Newcomen Society.—Caxton Hall, Westminster, S.W. 1. "The Rainhill Locomotive Trials of 1829," by Mr. C. F. Dendy-Marshall. 5.30 p.m.

THURSDAY, APRIL 25TH.

Institution of Electrical Engineers.—Savoy-place, Victoria Embankment, W.C. 2. The twentieth Kelvin Lecture: "Lightning," by Dr. G. C. Simpson, F.R.S. 6 p.m.

Institution of Locomotive Engineers (London).—Denison House, 296, Vauxhall Bridge-road, Westminster, London, S.W. 1. Annual general meeting. Paper, "Route and Speed Signalling," by Mr. G. H. Crook. 6 p.m.

FRIDAY, APRIL 26TH.

Institution of Electrical Engineers: Scottish Centre.—In the Hall of the Technical College, Bell-street, Dundee "Load Levelling Relays and their Application in connection with Future Metering Problems," by Mr. W. Holmes. 7.30 p.m.

Royal Institution of Great Britain.—21, Albemarle street, Piccadilly, London, W. 1. Discourse, "English Civilisation from Alfred to Harold, 900–1066." 9 p.m.

MONDAY, APRIL 29TH.

Institution of Automobile Engineers: Scottish Centre.—Royal Technical College, Glasgow. "Brakes," by Mr. W. P. Kirkwood. 7.30 p.m.

WEDNESDAY, MAY 1ST.

Institution of Automobile Engineers.—Joint meeting of the Birmingham and Coventry Graduates. Queen's Hotel, Birmingham. "High-speed Diesel Engines," by Mr. H. R. Ricardo. 7.30 p.m.

Institution of Electrical Engineers.—Savoy-place, Victoria Embankment, London, W.C. 2. Wireless Section meeting. The following paper will be read and discussed. "A Portable Radio Intensity Measuring Apparatus for High Frequencies," by Dr. J. Hollingworth, M.A., and Mr. R. Naismith. 6 p.m.

FRIDAY, MAY 3RD.

Institution of Automobile Engineers.—At the Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Joint meeting with the Institution of Production Engineers. "The Production and Application of Ground Gears," by Mr. H. F. L. Orcutt. 7.45 p.m.

Institution of Mechanical Engineers.—Storey's-gate, St. James's Park, London, S.W. 1. Informal meeting. "London's Water," introduced by Mr. Henry Berry. 7 p.m.

TUESDAY, MAY 7TH.

Institute of Metals.—Institution of Mechanical Engineers, Storey's-gate, Westminster, S.W. 1. Nineteenth May Lecture, "Some Ideas About Metals," by Sir Oliver Lodge, F.R.S. 8 p.m.

TUESDAY, MAY 14TH.

Royal Institute of British Architects.—Merchant Taylor's Hall, London. Annual dinner.

THURSDAY, MAY 23RD.

Faraday Society.—In the Rooms of the Chemical Society, Burlington House, Piccadilly, W. Annual general meeting, to read and discuss the Third (Experimental) Report to the Atmospheric Corrosion Research Committee (British Non-Ferrous Metals Research Association), presented by Mr. J. C. Hudson. 7.45 p.m.

An Interesting Marine Gear Shaft Repair.—A repair which was made to the second reduction gear wheel shaft of the ss. "Matakana," belonging to the New Zealand fleet of Shaw, Saville and Albion, Ltd., by Fescol, Ltd., of 101, Grosvenor-road, Westminster, S.W. 1, possesses some points of interest. While at sea the gear wheel worked loose on its shaft, and in the Colonies a temporary repair was effected by drilling and tapping by hand a series of holes with their centres on the joint line between the boss of the wheel and the wheel seating. Into these holes studs were then screwed with half the diameter in the boss and half in shaft. On arrival at London it was necessary to carry out permanent repairs, but the composition of the shaft was such that welding was considered inadvisable. It was decided to build up the wheel seat by the "Fescol" process of nickel deposition. The spare shaft was "Fescol-ised" in nickel to a diameter of $^{17}/_{16}$ oversize, after which the bore of the gear wheel was trued up, the shaft turned to size, and the wheel driven on the shaft. The original temporarily repaired shaft was also built up to give a suitable machining allowance, and is now carried as a spare shaft.